EXPERTIP

Category	DRYER
Keywords	Dryer fabric tension, stretch roll, air cylinders, hydraulic motors, screw jacks

Dryer Fabric Tension - Part 1

Understanding Dryer Fabric Tension Systems Key to Efficient Operation.

Operating with the proper system and at the correct fabric tension can help extend fabric life, reduce web shrinkage.

All dryer fabrics on paper machine dryer sections are equipped with fabric tension/stretch roll systems. The proper operation of these systems is essential for efficient drying and adequate fabric life and requires a thorough understanding of the functions of a tension system, methods of determining fabric tension, and some of the common operating problems.

Safety

Dryer fabric tensioning systems are highly complex, dynamic systems with moving equipment and several pinch points. It is important to understand this system and take the proper precautions prior to performing any troubleshooting or maintenance.

Tension System Functions

Figure 1 illustrates the tension device, or stretch roll, which facilitates the installation of a dryer fabric by providing slack in the fabric when the tension roll is moved to the short position (direction A).

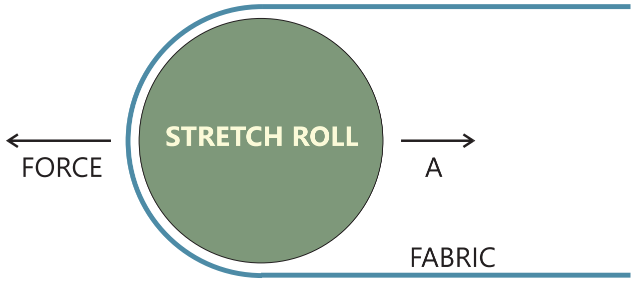

Figure 1.

The primary function of the tension system is to maintain tension on the dryer fabric. The dryer fabric should be kept under tension for several reasons:

- Sufficient tension is necessary for a fabric to drive rolls and, in the case of many new machines, to drive undriven dryers.
- Adequate fabric tension is necessary for proper guiding.
- Proper fabric tension has been shown to help reduce shrinkage of the paper web.
- A properly installed and operated tension device can avoid fabric damage by compensating for sudden increases in tension caused by wads and wraps.
- The dryer fabric serves to keep the wet sheet in contact with the dryer cylinder surface. Keeping the proper amount of tension on the fabric helps reduce the air layer between the paper web and the dryer. This tension prevents steam pockets from forming between the cylinder and sheet and counteracts the effect of centrifugal force, which tends to lift the sheet off the dryer.

Optimum Fabric Tension

The optimum fabric tension is primarily dependent on three factors:

1. The machine's ability to withstand the force applied to the fabric
2. The surface of the paper sheet
3. Machine speed

The **first factor** is the machine's ability to withstand the force applied to the fabric. Due to the likelihood of stress failure, machines equipped with small rolls, journals, non-anti-friction bearings, etc., cannot operate with as high a fabric tension as machines with larger rolls and antifriction bearings.

Excessive fabric tension can also create roll deflection, which results in fabric bowing. This, in turn, causes cross-machine-direction permeability variations and shorter fabric life.

The **second factor** that determines optimum fabric tension is the surface of the paper sheet. Higher fabric tensions can provide additional heat transfer on rough surface sheets by forcing better micro sheet contact. These same higher tensions may not provide any additional drying on smoother surface sheets, however, because a high degree of sheet contact already exists.

Machine speed is the **third factor**. As machine speeds increase, greater centrifugal force is exerted on the fabric and the sheet as they pass around the dryers. To offset the effect of this force, fabric tension can be increased.

The most commonly recommended fabric tension is 10 to 15 lb/linear in. (pli) or 17.5 to 26.2 daN/cm. Extensive laboratory testing as well as mill trials were conducted previously and showed that as dryer fabric tension increases, so does drying rate across all major paper grades. More detail covering these trials is reviewed in Part 2 of this ExperTip.

The maximum design tension capabilities on many new machines running at high speed necessitates higher fabric tensions range from 20 to 25 pli or 35.0 to 43.8 daN/cm. These machines are normally equipped with negative crown rolls to compensate for the roll deflection that will occur at these higher tensions.

Tension Systems

Tension is applied to the fabric by pulling the stretch roll to the tight side of the fabric (Figure 1). Air cylinders, weights, hydraulic motors, screw jacks, and calibrated springs can be used to apply this tension.

The following methods of tension calculation are intended to show the amount of tension being applied to the fabric by the stretch roll at the point of contact. The tension level throughout the loop will vary somewhat. For example, the level of tension on the fabric will be higher coming into the section as the fabric is being pulled into the section by driven rolls or gear-driven dryers. Generally, there will be less tension on the fabric as it enters the return run.

The weight system, one of the more commonly used systems, is illustrated in Figure 2. The following equation can be used to calculate the tension applied by this system:

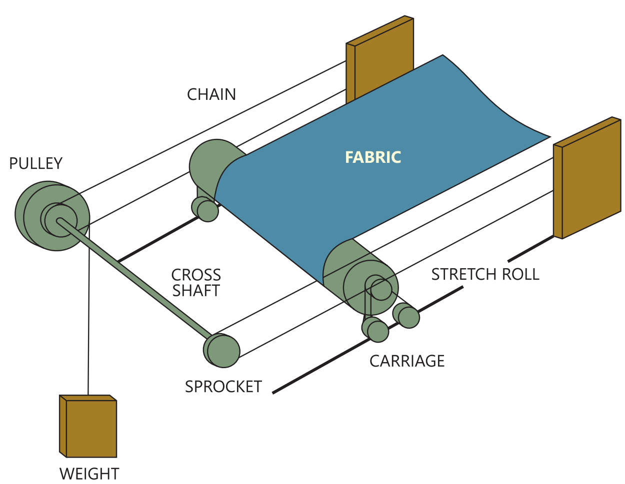

Figure 2.

$$\frac{(Applied\ Weight) \times (Mechanical\ Advantage)}{2 \times Fabric\ Width} = pli\ (daN/cm)$$

$$\frac{Pulley\ dia}{Sprocket\ dia} = Mechanical\ Advantage$$

or, to calculate the weight to be added:

$$\frac{(2 \times Fabric\ Width) \times (Target\ Tension)}{Mechanical\ Advantage} = Applied\ Weigth$$

These weights are commonly round blocks of iron or steel, and if they are made of cast iron, the following calculation should be used to determine their total weight:

$$Volume = \pi \times R^2 \times H$$

$$Total\ Weight = 0.285 \frac{lb^3}{in} (7.873 \frac{g}{cm^3}) \times Volume$$

If the weights are steel, the volume should be multiplied by 0.282 lb/in^3 (7.900 g/cm^3).

A more complex weight system is the weight/counterweight system (Figure 3). In this system, gross adjustments to the stretch roll position are made with a motor (A), and tension is applied by weights (B). Fine adjustments to the amount of tension can be made by adding or deleting counterweights (C). The length of the steel band leading from the weights to the pulley can be adjusted by a second motor (D). Adjustment in the steel band length keeps the weight carriage in the proper position.

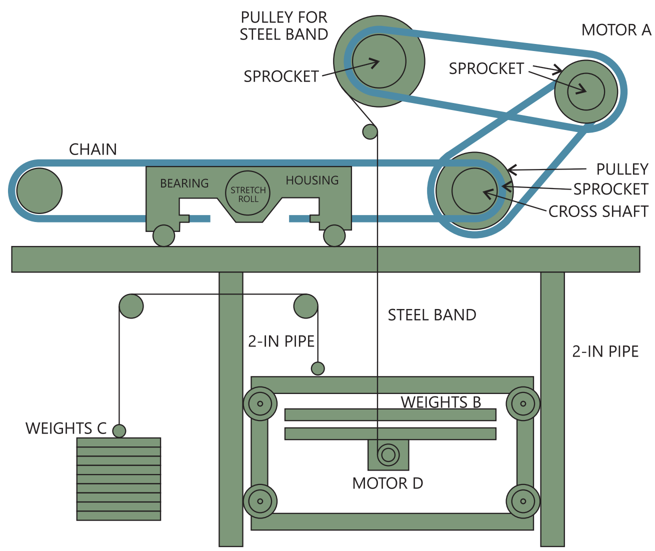

Figure 3.

The force applied by this system is the total weight of the carriage, motor (D), and weights (B) minus the total of the counterweights (C). The mechanical advantage is the diameter relationship of the pulley and sprocket located just before the stretch roll (pulley diameter divided by sprocket diameter).

Most older machines were equipped with weight systems. However, many of these older machines have been retrofitted with air cylinder systems.

This system applies force to the stretch roll by using an air cylinder (Figure 4).

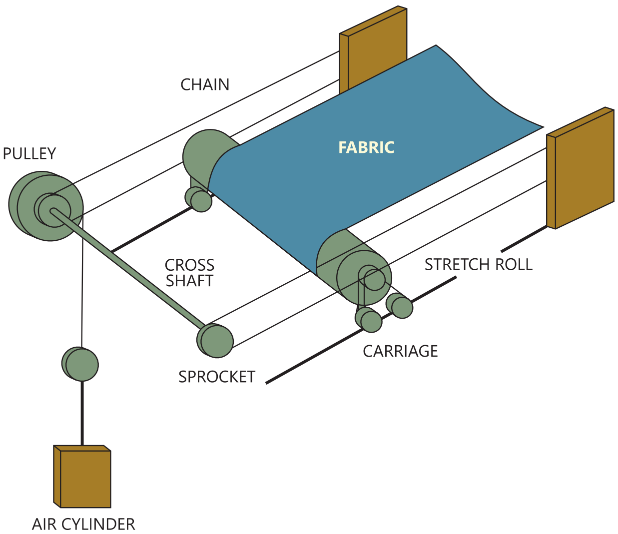

Figure 4.

The same equation used to find pli for the weight system may be used for this system. Applied weight can be found with the following calculations:

$$Piston\ Area\ =\ (Bore\ Radius^2)\ \times\ (\pi)\ -\ (Piston\ Rod\ Radius^2)\ \times\ (\pi)$$

$$Piston\ Area\ \times\ Air\ Pressure\ =\ Applied\ Weight$$

When the cylinder is opposed by two cables [Figure 5), the applied weight must be divided by two since equal force is applied to each of the cables.

Another system that uses air cylinders is illustrated in Figure 6. In this double air cylinder system, a motor is used to make gross adjustments to the stretch roll. Tension is maintained by two air cylinders, one located on the front side and one on the back side of the machine, each of which applies pressure to a lever attached to the cross shaft.

The lever arms act like the pulley in conventional air cylinders or weight systems. The force applied is the total of the two cylinders.

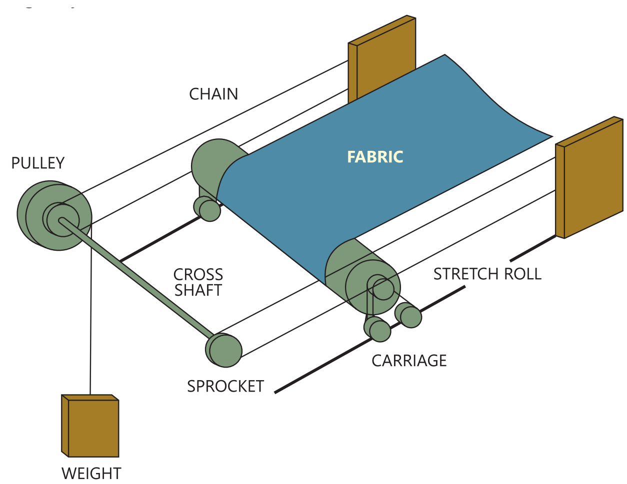

Figure 5.

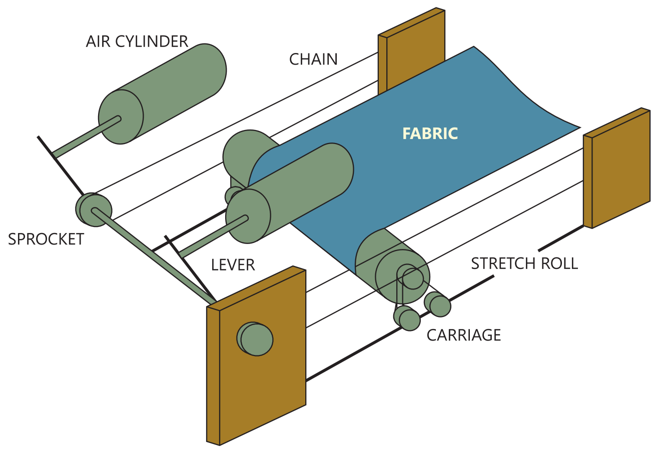

Figure 6.

$$Force\ =Piston\ Area\ \times 2\ \times Air\ Pressure$$

$$Tension\ =\ \frac{Force\ \times\ (Lever\ Arm\ Length\ \times\ 2)}{Sprocket\ Dia/2\ \times Fabric\ Width}$$

The hydraulic motor brake system maintains tension on the fabric with a hydraulic motor under constant hydraulic oil pressure. The oil is pumped to the hydraulic motor by an electric motor-driven pump. Therefore, if electrical power is lost, the system loses pressure, and fabric tension is lost.

To avoid the loss of fabric tension in the event of a power loss, a brake is interlocked with the hydraulic pressure system. The brake will engage, holding the fabric tension, if the hydraulic pressure falls below a preset level. The force applied by this hydraulic motor depends on the motor stall torque and the hydraulic oil pressure.

The wrapped stretch roll system is used in some new machines (Figure 7). In this system, the chain wraps the stretch roll instead of being anchored to it. In this way, the force applied to the stretch roll by the weights or cylinders is doubled. To calculate the amount of tension on the fabric, the equation appropriate to the method of applied force may be used. The resultant fabric tension must, however, be multiplied by two.

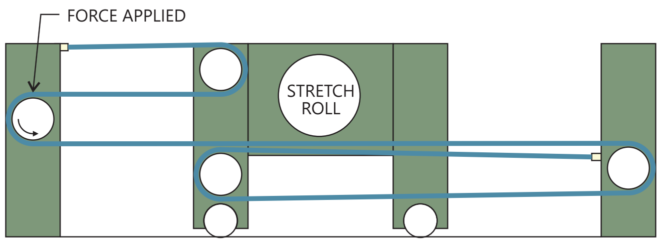

Figure 7.

The screw jack is a tension device used in many older machines (Figure 8). In this system, the stretch roll bearing housings are threaded to receive a threaded shaft. Tension is applied to the fabric by turning a hand wheel attached to this shaft. There is no way to determine the exact amount of tension applied in this way.

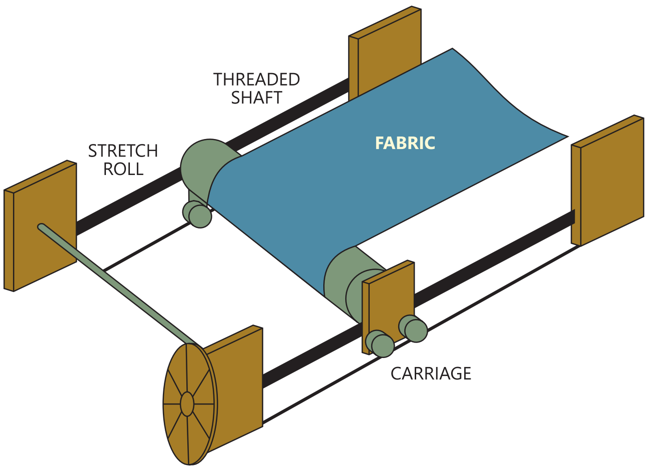

Figure 8.

There are some cases of force being applied to the stretch roll with calibrated springs. In these cases, the same basic equation may be used. However, the applied weight must be determined by the spring calibration.

A method of determining, and possibly automatically controlling, the amount of force being applied to the fabric without calculations requires using a load cell. The load cell may be positioned on the stretch roll in direct opposition to the force being applied to the roll (Figure 9). The load cell electronically senses the force being applied to the roll.

Commercial systems that use a load cell in conjunction with an electrical motor or air motor to control fabric tension automatically are available. In one such system, the motor tightens or releases a chain wrapped around the stretch roll until the proper tension is reached.

In another such system, the motor drives a worm gear-threaded shaft that positions the stretch roll. This system is similar in concept to the previously mentioned screw jack system.

Common Tension System Operating Problems

While it would be impossible to discuss every possible problem that a mill could encounter with a stretch system, some of the more common problems are outlined in the following paragraphs.

The stretch roll should be checked frequently for misalignment. This can be done by measuring the distance from the center of the stretch roll bearing housing to the stretch roll stop on both the front and back sides of the machine. If the two measurements are not the same (within 1/16 in. (4mm) or less), the sprocket should be checked to determine if it has jumped a link in the chain. A malfunction of the carriage mechanism on which the stretch roll moves back and forth might also cause misalignment. These carriages should be checked periodically to make sure that the stretch roll is able to move freely on both the front and back sides of the machine. Worn out bearings or dirty slides frequently cause the carriage mechanism to lose mobility. Occasionally, however, the stretch roll is purposely misaligned to compensate for misalignment elsewhere in the section.

If the fabric has more slack than expected for the amount of weight or force being applied, there may be a problem with the cable. The cable may have slipped off the main pulley or one of the idler pulleys or it may be «hung up» on something. The weights should not be hindered in their up-and-down movement by some obstruction, and they should not come to rest on the floor.

Air cylinders should be checked to determine that they are in either the bottomed-out or full-stroke positions. If the piston has bottomed out, the end of the connecting rod will have come to rest close to the top of the cylinder. If the piston is at full stroke, the exposed part of the connecting rod will be nearly the same length as the cylinder. The air cylinder opposed by two cables allows adjustment of the piston height by the use of a cable winch (Figure 4). If the piston has bottomed out, the cable can be shortened, or if the piston is at the top of its stroke, the cable can be lengthened by using the cable winch. If the air cylinder is opposed by only one cable, the adjustment must be made by lengthening or shortening the cable or by adjusting the number of wraps of the cable on the pulley.

All of these checks should be made following a dryer fabric change. If the system contains more than one air gauge, the air gauges should be compared frequently to determine accuracy. If there is only one gauge in the system, it should be changed occasionally to check accuracy.

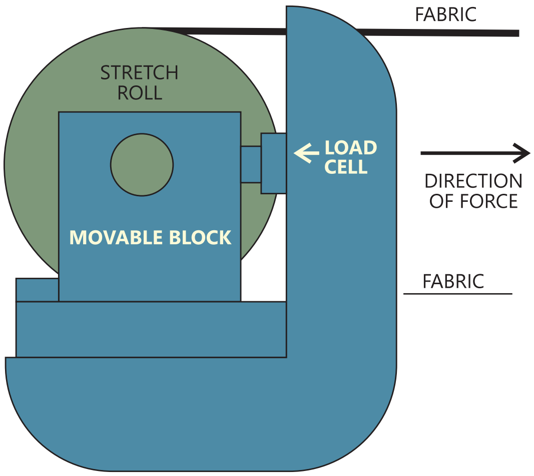

Figure 9. Possible load cell location.

Air pressure can be lost if the air lines become pinched or broken. One way to check for these problems is to install gauges at both ends of the air line and to compare the readings to determine if air pressure is being lost. These gauges are usually located at the operators panel and the cylinder. Compensation for height differences and pipe lengths should be calibrated into the gauges.

The air cylinder should be examined for leaking seals. Load cells should be recalibrated or replaced occasionally to ensure accuracy.

The hand wheel should be used only to make gross adjustments to the stretch roll (Figure 10). It should never be used as the primary source of pressure on the stretch roll. After the hand wheel is used, as in the case of a fabric change, care should be taken to see that it is left undogged

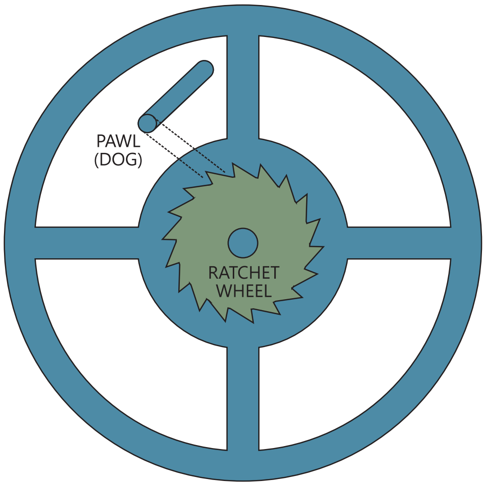

Figure 10.

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2. N. Blocker, «Understanding Dryer Fabric Tension Systems Key to Efficient Operation» Pulp & Paper, July 1991

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