

## WHAT'S TENSION CONTROL ?

The tension control is the ability to permanently control the mechanical tension in any material (mainly the raw material available in roll size). This control has to be operated dynamically and statically. On every machine the operator should be only concerned by the speed and operation. The line speed is considered as master function. The tension control must be efficiently at any machine speed phase, including machine acceleration, steady and speed deceleration.

Emergency stop case does not require accurate tension control but should act in the way to avoid the web breakage. It is then very important to consider all machine speed phases for the system determination.

## WHERE DOES IT APPLY ?

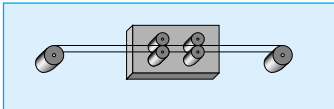
In any roll fed web processing machine. Typically :

- PRINTING machine
- LAMINATING machine
- SLITTING machine
- SHEETING machine
- COATING machine
- EXTRUDERS
- Stand alone UNWINDER / REWINDER
- In general all CONVERTING equipment

Treating material such as:

- Paper
- Plastic film
- Textile
- Aluminium foil
- Wires / cables

In general in all machines whose block diagram can be represented as follow:

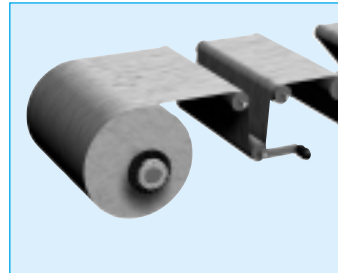
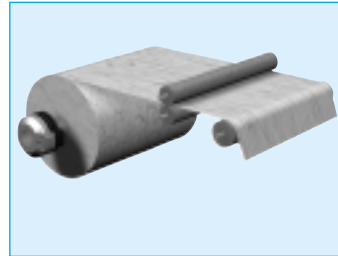


## WHY A TENSION CONTROL ?

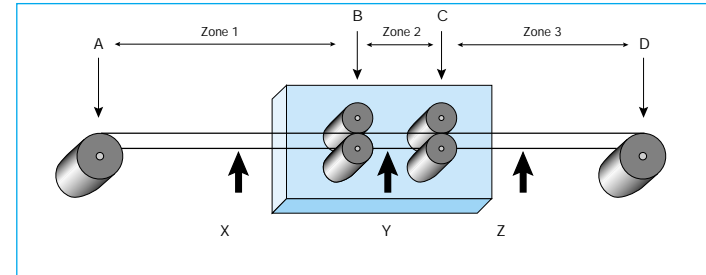
When web material has to be treated in a specific machine (printer, slitter, coater ...) it is very important to transport the web with a controlled tension for two main reasons :

- Correct web transport in the machine
- Correct operation on the transported material

On the other hand, this kind of machine works very often with an "edge guiding system". Loosing the tension in material will affect the correct edge guiding system.



## GENERAL BLOCK DIAGRAM



## IMPORTANT CONSIDERATION

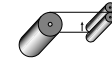
In every machine the speed point location must be clearly identified. In general one of the machine nip roll is driven setting the linear velocity of the machine. The machine speed is considered as **MASTER** function. The tension control, whatever the chosen solution, works in **SLAVE** mode. Practically, the operator sets the machine speed with a simple potentiometer and all tension control system existing on the machine have to follow, keeping the desired tension at any speed and during all transitory speed phases.



## REFERING TO THE GENERAL BLOCK DIAGRAM

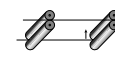
Three zones are clearly identified :

### ZONE 1, Typical characteristics (unwind)



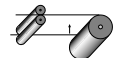
- Tension zone definition : A-B
- Speed point in B
- Variable roll rotation speed
- Variable inertia
- In general constant tension X
- Brake system applicable
- Motor system applicable

### ZONE 2, Typical characteristics



- Tension zone definition B-C
- Speed point in C or B
- Constant roll rotation speed
- Constant inertia
- In general constant tension Y
- Brake system applicable
- Motor system applicable

### ZONE 3, Typical characteristics (rewind)



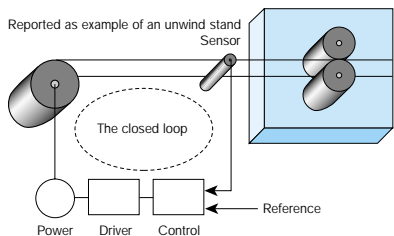
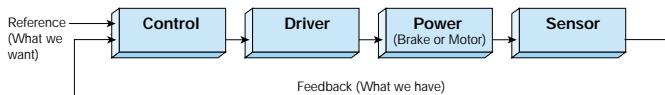
- Tension zone definition C-D
- Speed point in C
- Variable roll rotation speed
- Variable inertia
- Constant or Taper tension Z
- Brake not applicable
- Motor system required

**NOTE :** Each zone is individually controlled. Tension may be different in each zone. It is assumed that there is no slipping on the nip roll.



## CLOSED LOOP SOLUTION

The tension control, as any electronic control, is working basically in closed loop according the electrical block diagram below. In closed loop we **sense the result we want to achieve** and compare it with a reference in order to ensure permanent balance between what we want and what we have.



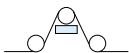
The closed loop is an electrical/mechanical loop. It's easy to understand that in such a loop all parts are important in terms of quality.

- The control – has to have high performance to manage all parameter changes correctly during the operation.
- The driver – has to be as fast as possible in terms of response.
- The power part – has to be sized correctly according the need and as fast as possible in terms of response.
- The sensor – has to be accurate, stable over time and to have a good repeatability.

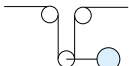
The quality of the mechanical construction is important. The control loop is closed through the mechanical transmission between the power element and the sensor roll. The web itself is a part of the loop. In the case of webs with high elasticity, special consideration should be given in control setting.

## THREE WAYS TO SENSE THE TENSION

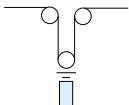
**Direct tension** measurement with **LOAD CELL**.



**Indirect tension** measurement with **DANCER ARM**.

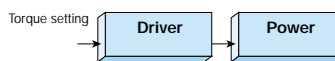


**Indirect tension** measurement with **FREE LOOP**.



## OPEN LOOP SOLUTION

The open loop configuration does not require any control or sensor. It is composed only with a power element (brake or motor) and an associated driver. In this case the torque is **not controlled**. We have to **set the torque** on the driver according to the diameter of the roll. The electrical block schematic drawn from the closed loop system becomes as follows:



The power part is transmitting the necessary torque to the roll. Since the result is not measured, all the effect due to the inertia of the roll influence the tension in the web. Some compensations are possible but the system stays an open loop with limited accuracy.

## THREE POSSIBILITIES TO APPLY THE SETTING

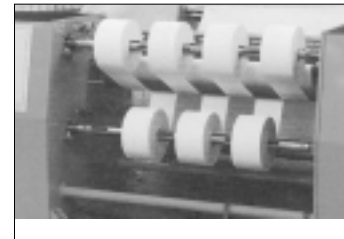
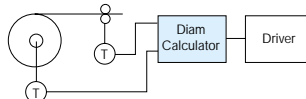
**MANUAL** by **potentiometer**



**AUTOMATIC** with the **diameter reading**



**AUTOMATIC** with the **diameter calculation**



The diameter calculation is based on line and rotation speed information.

This solution requires to have both information available.

To summarise, the web tension control can be operated in two system configurations **OPEN** and **CLOSED** loop. For each configuration, three main possibilities for **SETTING** respectively **SENSING** are possible. The solution choice depends on :

- First the accuracy you need in your web tension
- The mechanical construction of the machine
- The degree of automation you need
- The acceleration/deceleration imposed on the system

In the next section **WARNER ELECTRIC** gives you some criteria to facilitate your choice. It's not our intention to impose a solution but just to offer a guide drawn from the **WARNER / WICHITA** experience. We put the accent on the limit of various possibilities in order to start your project on a healthy base and really get the result you are expecting.