A simple method for determining drive roll load shares on machines with line shaft drives

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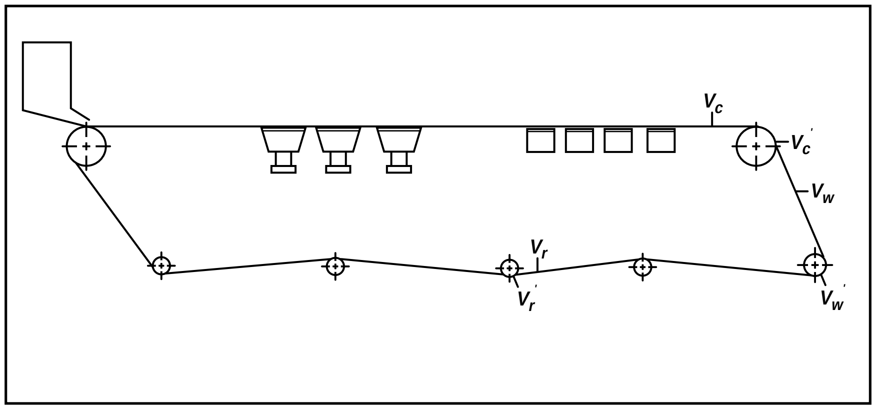
On machines that are not totally electrically driven, there is often little knowledge about the relative load shares and dragloads. In the best of cases, torque curves might be available. Nonetheless, the information is not typically very accessible. The simple method provided here allows the user to determine load shares and total dragloads at any time the machine is in operation.

We previously described a method of determining dragloads and drive energy by accurately measuring fabric speeds.[1] These speeds are then used to calculate dragloads and energy. These calculations were made by the following equations.

1. The speed of a fabric going into a roll is equal to the roll speed: $V_c = V_c'$, $V_w = V_w'$, $V_r = V_r'$.



$$DL = \left(\frac{V_b}{V_a} - 1 \right)(EM + T_a) \qquad (1)$$

where,

DL = Dragload, pli

V_b = Fabric speed at point b, ft/min

V_a = Fabric speed at point a, ft/min

EM = Fabric modulus of elasticity, pli (provided by your fabric supplier)

T_a = Fabric tension at point a in pli

And, horsepower is then calculated by,

$$\text{hp} = \frac{DL \times V \times s}{33{,}000} \qquad (2)$$

where,

hp = Horsepower

DL = Dragload, pli

V = Average fabric velocity, ft/min

s = Fabric width, in.

A tachometer and tensiometer were required to carry out the necessary machine data collection. If, however, your primary ambition is to obtain load shares, it is sometimes easier to use a strobe light in place of the tachometer. By simply marking three rolls, using the strobe, and then calculating the speed of these rolls, one can easily determine the load share and energy demand of a typical machine.

The speed of the fabric at the in-going nip of a roll is equal to the speed of that roll (Fig. 1). The actual speed of the roll (and hence fabric) can be easily determined with knowledge of the roll's rotational velocity and the roll's outer circumference. To actually determine roll speed, one would use the following equation,

$$V_r = \pi \times D_r \times \omega \qquad (3)$$

where,

V_r = Roll speed, ft/min

[1] McMahon, M.J., *Tappi J.* 76(4): 89(1993).

Sample calculations:

Data obtained for calculations:
Couch roll specifics:

ω = 200 rpm, D_r = 35-15/16 in.

Wire turning roll:

ω = 214 rpm, D_r = 33-1/2 in.

Wire return roll:

ω = 351 rpm, D_r = 20-3/8 in.

Forming fabric width = 280 in.

Forming fabric modulus of elasticity = 7000 pli

Fabric tension by return roll = 30 pli

Speeds

Couch roll

(3.14) (200) (35.9375/12) = 1881 ft/min

Wire turning roll

(3.14) (214) (33.5/12) = 1876 ft/min

Wire return roll

(3.14) (351) (20.375/12) = 1871 ft/min

Dragloads

Wire turning roll

[(1876/1871)-1] (7000 + 30) = 19 pli

Couch roll

[(1881/1876)-1] (7000 + 30 + 19) = 19 pli

Total dragload = 19 + 19 = 38 pli

% load share

Couch roll

$$\frac{19}{19 + 19} \times (100) = 50\%$$

Wire turning roll

$$\frac{19}{19 + 19} \times (100) = 50\%$$

Horsepower

Couch roll

$$\frac{(19)\,(1876)\,(280)}{33{,}000} = 302 \text{ hp} \qquad (4)$$

Wire turning roll

$$\frac{(19)\,(1876)\,(280)}{33{,}000} = 302 \text{ hp} \qquad (5)$$

Total horsepower = 302 + 302 = 604 hp

D_r = Outside roll diameter, ft (to the nearest 1/64th of an inch)

ω = Roll rotational velocity, rpm

π = 3.14

To determine the load share of a machine driven by a couch and wire turning roll, for example, you would require the roll speeds of three rolls (the couch, the wire turning roll, and a wire return roll) and running these speeds through Eqs. 1 and 2.

A word of caution, however. The wire return roll is typically the most difficult speed to accurately determine, due to interference from doctor blades and knock-off showers. Consequently, it is suggested here that one uses a roll that is not doctored, not adjacent to a knock-off shower, or both, to avoid error. Sometimes it is best to average a few return roll readings. Let experience be your guide here.

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