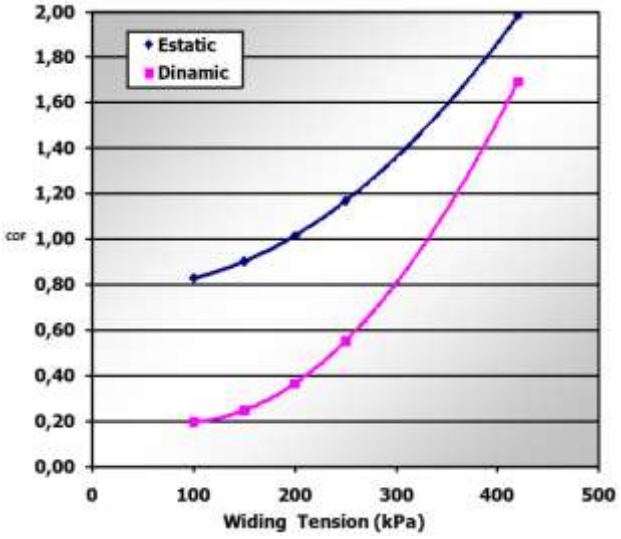
BULLETIN: FILM WINDING TENSION EFFECT ON COF

Studies performed on coextruded films with polyolefin and more specifically, on blends of LLDPE/LDPE show that there is a strong dependence between the tension applied during the film winding and the coefficient of friction (COF). Otherwise, these same studies reveal that the COF is independent of the extrusion temperature used.

A regression analysis of data obtained from the study reveals that the COF has an exponential dependence with respect to winding tension; the COF increases proportionally as the square of the applied winding tension (WT). The regression fit equations are shown below:



$COF(Static)=0,80-(5,09.10^{-4}).WT+(7,90.10^{-6}).WT^2$
$R^2=0,90$ (1)

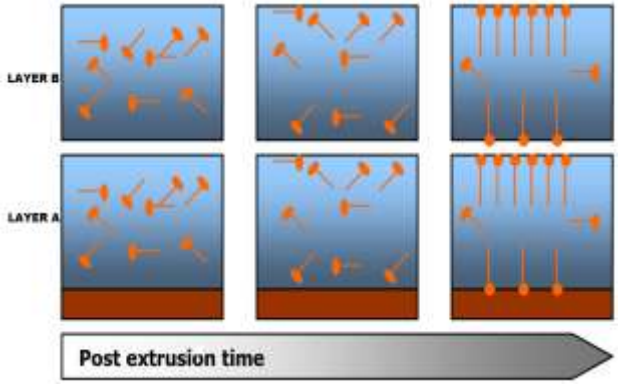
$COF(Dynamic)=0,30-(2,40.10^{-3}).WT+(1,36.10^{-5}).WT^2$
$R^2=0,91$ (1)

(1) Note: R^2 is a measure of the goodness of fit, that goes between 0 (null) and 1 (perfect). So, a R^2 of 0,9 indicate that the adjustment explain the 90% of the dates.

As observed in both equations, both static and dynamic COF show dependency relationship with respect to the winding tension on similar characteristics.

The model shows that for each increase of 50kPa in the winding tension, the static COF increase by 15% and the dynamic COF in 40%. Greater sensitivity of dynamic COF to changes in winding tension may be a common cause of faults or anomalies that occur in post extrusion stages such as: cutting, printing and automatic packing or FFS (with Formed – Packaging - Filling and Sealing).

The phenomenon of inhibiting the migration of slip agent generated by the increase of winding tension is produced as effect of the decrease of free energy of exothermic separation originated by the high pressure between the faces of the film. Thus the slip-agent molecules, instead of migrating to settle on the faces of the film, migrate from one surface to another, reducing the effective concentration of slip-agent required to have desired COF. The following diagrams illustrate the phenomenon described.



In the precedent representation, the slip-agent molecules move towards the free surfaces of the film, allowing the polar group of amide molecule, incompatible with PE, to forms the slippery film. As there is no excessive pressure on the winding, the amide remains on the surface and does not migrate.

In the second scheme is represented the two faces of the film in close contact, which occurs at high winding voltages. In this case, the slip-agent molecules move between the layers, looking for the free surface of the roll, which will result in low sliding values in the inner layers.

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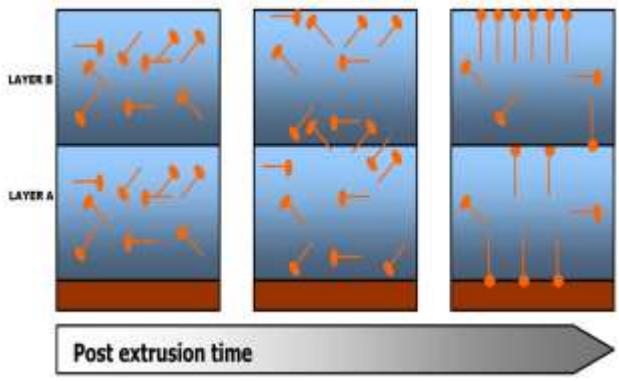

Based on this mechanism it can also be anticipate that those extrusion lines, coextrusion, lamination, cutting, among others, which have central tension winders, will have a heterogeneous distribution of slip agent with higher COF in the center of the roll.

Given the evidence of sliding problems arising from winding tension, it is recommended:

- Decrease the winding tension up to a value that prevents the occurrence of defects in the roll, such as "telescope". Once stability value has been reached, do not increase the tension.
- Reinforce the additivation of the resin with a sliding agent concentrate, adding small doses from 200 to 250 ppm in cases where COF problems associated with the winding tension are present and cannot be reduced.
- Finally, it is convenient to remember that although the temperature of extrusion has low influence on the COF, it is not recommended to modify it.

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