SEALABILITY OF BIORIENTED FILM

As already mentioned the bioriented film can not be welded since during this process it tends to shrink without getting a good diffusion of the polymer chains.

In order to get the bioriented film sealable, it is necessary to apply the following technologies:

- co-extrusion
- lacquering
- lamination

They are based on the combination of the bioriented film with other resins which can be welded at a temperature lower than the deformation temperature of the broriented primary film (about 14OC).

In addition, those techniques give the film other characteristics like:

- Improved barrier properties
- Possibility to get a sandwich printing
- Properties impossible to get with a single layer

Co-extrusion

- In this case the polypropylene resin and the others are extruded contemporaneously through a unique extrusion flat die.
- The composite layer film then goes on the standard bioriented line production steps.
- The resins used in order to get good production results should be very close to the polypropylene resin from the rheological point of view.
- Generally it is used a random copolymer whose sealabilty temperature is very low. The sealable outside layer thickness is usually no more than 2 microns.
- This process is the more economic being carried out in one step.
- From the welding workability point of view it requires more attention compared to the lacquered film.

Lacquering

With this technique, the sealable resins are applied on a film already formed. The lacquers generally used are:

- VC/AV copolymers
- PVDC copolymers
- Acrylic resins

From the processing point of view the lacquered film is more similar to the cellulosic film and may replace the latter without difficulties in the automatic flexible packaging.

The lacquered film can be printed without pre-treatment being the lacquers polar while the co-extruded film needs electrical corona pre-treatment.

The lacquer thickness usually is no more than 2 microns.

Lamination

In this case two or more films already formed are combined by means of adhesives or/and an extrusion coating lamination. As a rule, the laminated film otters properties which are not possible to get in a single layer.

For instance the aluminum foil gives very good barrier properties in the packaging field but has to be laminated to a polyethylene or polypropylene (non oriented) sealable film from one side and bioriented film from the other side in order to increase its poor elongation and mechanical resistance.

On the market there are a great deal of films available giving possibility of getting many composite flexible films with outstanding properties.

We may quote the following, together with the relevant indicative density values:

Film	Density	Unit
PA (polyamide)	1.15	g/cm^3
PET (polyester)	1.5	g/cm^4
RE (polyethylene)	0.925	g/cm^5
PP (polypropylene)	0.9	g/cm^6
PC (polycarbonate)	1.2	g/cm^7
PVDC (polyvinylidene)	1.65	g/cm^8
Cellulosic film	1.4	g/cm^9
PVAL (polyvinylalcohol)	1.3	g/cm^{10}
PS (polystyrene)	1.05	g/cm^{11}
PVC (polyvinylchloride) film	1.4	g/cm^{12}
Al (Aluminum foil)	2.7	g/cm^{13}
Paper	0.8	g/cm^{14}

The main lamination techniques used are the following:

- extrusion coating
- extrusion lamination
- lamination with adhesives
- lamination with wax/hot melts

Using polypropylene film, the lamination is carried out generally by means of adhesives.

The lamination process can be divided into two ma)or categories namely wet bonding and dry bonding.

Wet bonding

It uses solvent or aqueous based adhesives. In this case one of two film layers is porous with good permeability to solvent and water in order to facilitate the liquid evaporation.

The combination of the layers is made when the adhesive or glue is still humid.

Wet bonding is not advisable for the lamination of plastic films due to their low permeability. It is mainly used to laminate paper.

Dry bonding

In this process. adhesives in solution (aqueous or solvent-based) or a hot melt adhesive are used. With the adhesives in solution, the lamination occurs after the film is dried and the water or the solvent has been removed. This technique is the most consolidated one.

The system is easier to process and the laminated film offers very soon a rather good adhesion among the component layers.

Figures 7 and 8 sketch the lay-outs of the different processes.

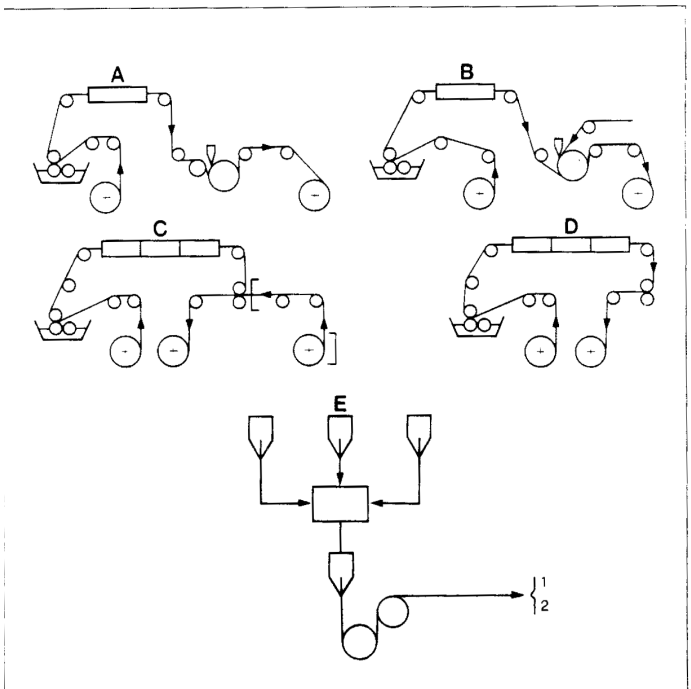

Fig. 7 - Layout of different processes for the production of bioriented heat-sealable film (A = extrusion coating; B = extrusion amination; C = lamination; D = lacquering process; E = co-extrusion process; 1 = windup; 2 = stretch).

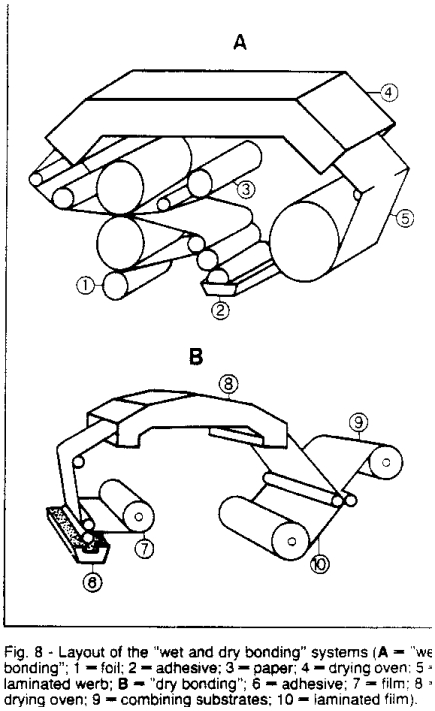

Fig. 8 - Layout of the "wet and dry bonding" systems (**A** = "we bonding"; 1 = foil; 2 = adhesive; 3 = paper; 4 = drying oven; 5 = laminated werb; **B** = "dry bonding"; 6 = adhesive; 7 = film; 8 = drying oven; 9 = combining substrates; 10 = laminated film).