Effect of Calcium Carbonate on Specific Film Properties

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The addition of minerals always affects the properties of film or sheeting. It is therefore all the more important for manufacturers to obtain precise information about the minerals they use. Below, we describe the effect of calcium carbonate on properties such as light transmission, light ageing, permeability to water vapour and other gases, and stress-crack resistance.

1. Light Transmission

Agricultural applications of filled polyethylene film and sheeting depend on their light transmission. It could be assumed that a filler would reduce the light transmission of sheeting. However, the growth of the plants beneath the sheeting is affected not only by directly transmitted sunlight, but also by the diffusely scattered sunlight reaching the plants.

Figure 1 lists the light transmission coefficients of calcium carbonate-filled agricultural sheet, measured over a hemisphere in the ultraviolet, visible and near infrared ranges. Surprisingly, a 10% calcium carbonate content in LDPE films decreases their light transmission by only 4%. This loss is more than compensated for by the fact that the sunlight that reaches the plants is now diffused.

2. Water Vapour and Gas Permeability

In many applications, water vapour and gas (e.g. oxygen) permeability play an important role. Table 1 shows the values for LDPE films with a thickness of 75 µm.

The conventional filler contents of 10 to 15 % reduce water vapour permeabili-

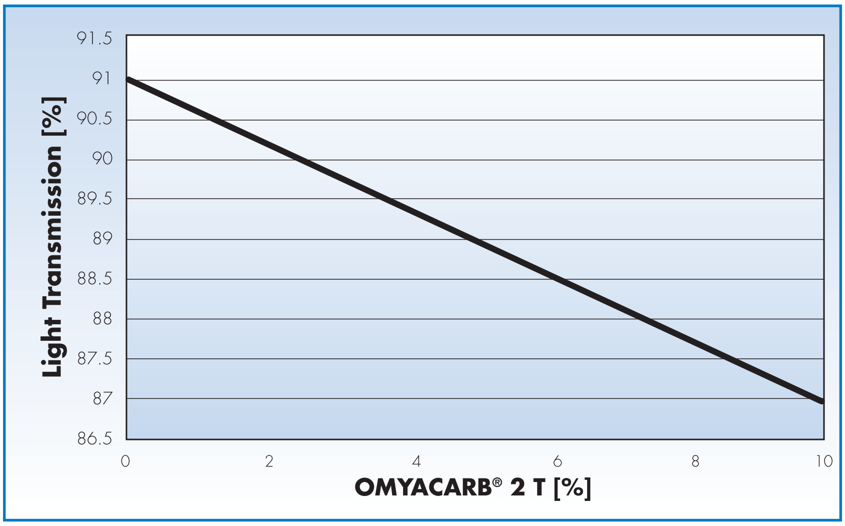

Figure 1: Effect of OMYACARB® 2 T on the light transmission of an LDPE film.

ty by 10 to 15%. Oxygen permeability is an important property in packaging film, for example. A calcium carbonate content of 14% reduces it to 71.5% of the original value for LDPE without $CaCO_3$. This improves the quality of the polyethylene film. Only the nitrogen permeability, which is unimportant for packaging purposes, is increased by the addition of calcium carbonate, since nitrogen has a lower polarity than oxygen.

OMYACARB® 2 T content	Permeability for		
	Water vapour	Oxygen	Nitrogen
[%]	[g * m⁻² * d⁻¹]	[cm³ * m⁻² * bar⁻¹ * d⁻¹]	[cm³ * m⁻¹ * bar⁻¹ * d⁻¹]
0	5.75	115.9	19.7
3.5		102.6	24.5
4	4.87		
7		83.4	26.9
8.5	5.41		
14		82.9	26.6

Table 1: Water vapour and gas permeability of calcium carbonate-filled LDPE film and sheeting.

OMYACARB® 2 T [%] content	Radiation energy up to 50% residual tear strength [kJ/cm²]	
	Unstabilised	Stabilised (0.15 % Tinuvin 622 / 0.15 % Chimasorb 81)
0	210	1071
1	202	1176
3	193	1176
5	193	1008
10	172	924
1% kaolin	143	588
3% kaolin	101	378

Table 2: Effect of calcium carbonate on the UV stability of 200 µm LDPE film (504 kJ/cm², corresponding to 1 year's outdoor weathering in Florida or 3 years in Oftringen/Switzerland).

4. Stress-Crack Resistance

Calcium carbonate greatly improves the stress-crack resistance of highly filled HDPE (and LDPE), measured by the Bell test. Figure 2 shows this improvement with the example of two different HDPE grades. The effect may be the result of the mineral increasing the amorphousness of polyethylene.

3. Light Ageing

Films and sheeting of LDPE or LDPE/LLDPE blends for use in agriculture, construction sheeting and other outdoor applications require good ageing resistance. The effect of minerals on the ageing of polyethylene film is assessed by measuring the drop in mechanical properties as a function of time under uniform UV exposure.

The test values given in Table 2 show that calcium carbonate does not cause photosensitisation of LDPE, unlike silicates such as kaolin, which reduce light stability.

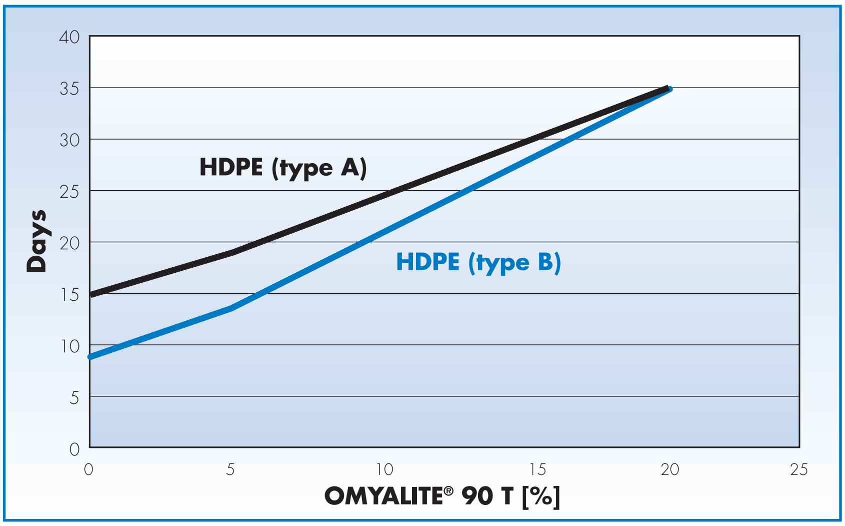

Figure 2: Stress-crack resistance of HDPE as a function of $CaCO_3$ content.

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