The multifunctional additive for a high performance wallboard line.

BEYOND RETARDING EFFECT

> Extension of the initial stiffening without slowing the setting speed.
> Cost effective price for a given effect.
> Easy to handle and to dose.
> Regular, reliable.
> No health hazard - Biodegradable product.
> Shelf Life: 3 years.
> Not affecting the strength of the final product.
> Compatible with other additives.
> Not nourishing moulds.
PLAST RETARDL
The multifunctional additive
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1.1 Definitions

For the better understanding it is useful to give, first, some definitions of the terms used in the following:

**Stucco:**
generally a calcined Gypsum but usually designating Plaster of Paris. Mixed with water into a slurry it hardens to a solid body.

**Plaster:**
Calcined Gypsum of any type, generally formulated with functional additives or/and inert aggregates.

**Water/Plaster ratio (W/P):**
a measure for the amount of gauging water in a plaster slurry.

**Setting:**
the mechanical hardening process of a plaster slurry. We distinguish:
- The initial setting = first stiffening of the slurry;
- The final setting = generally the point where a moulded body is hard enough to be handled or, in the case of a wall plaster, the finishing must end;
- The speed of setting = the maximum slope of the setting function.

**Hydration:**
the chemical process of recombination of crystalline water (generally called Combined Water, CW).

**Retarder:**
an additive postponing the initial setting or/and slowing the speed of setting.

**Accelerator:**
the opposite of a retarder; an additive shortening the initial setting and speeding up the setting.

**Starter (ground raw gypsum):**
kick-starts and speeds up the setting by providing germs of crystallisation.

1.2 The use of Plast Retard L in Plasterboard production

There are two main applications of gypsum plasters: moulding of prefabricated products, like plasterboard or plaster blocks; and powder products for application on site like gypsum wall plaster. It is obvious that in powder products only dry additives can be used.

By contrast, in prefabrication, liquid products are advantageous. **Plast Retard L** is a powerful liquid retarding agent for gypsum plaster. It is therefore, in particular, suitable for applications in wallboard plants. The dry variety of Plast Retard, suitable for powdery admixtures, is **Plast Retard PE** (see other brochure).

This brochure deals solely with **Plast Retard L** because the conditions for manufacturing prefabricated products are completely different from those of powder products applied by people on site.

Since Plasterboard is by far the most important product, we will concentrate on the specifics of **plasterboard production**.

For better understanding, we show in figure (1) a sketch of a typical plasterboard line.

The conditions for an economical operation are:

- A low water/plaster ratio is welcome. It saves drying energy and increases the drier capacity;
- The costs of the formula should be as low as possible;
- Off-spec production has to be avoided;
- Reduced maintenance requirements have a major impact on costs.

Thus, it is standard practice to dress the setting characteristics by the combined use of **starter and retarder** (occasionally also accelerator).
For a safe and reliable production the needs are (amongst others):

at point 1 an easy flowing slurry, setting starts behind forming station;

at point 2 a board core, stiff enough to be safely cut;

at point 3 a board core (ideally) completely re-hydrated.

Those requirements translate into setting characteristics:
- Extended time without stiffening;
- Rapid and complete hydration.

1.3 The benefits of Plast Retard L in Plasterboard production:

- Plast Retard L has proven to be the most efficient and reliable retarder for this purpose;
- Plast Retard L can easily be metered by conventional volumetric metering pumps;
- Plast Retard L, in many cases, if properly used, reduces the water demand;
- Plast Retard L poses no health hazard or other inconveniences;
- Plast Retard L is completely dissolvable in water;
- Plast Retard L retarding efficiency (measured by extension factor) is unaffected by the water/gypsum ratio;
- Plast Retard L addition does not modify the bond of paper on the gypsum core;
- Plast Retard L is unaffected by pH values between 7 and 10;
- Plast Retard L is compatible with the additives used in Plasterboard production such as starch, plasticizers and surfactants which control properties as paper bond, fluidity and density.
2.1 More about Retarders

2.1.1 Efficiency

Different retarders act differently on plasters in terms of:

- Effectiveness;
- Slope of the setting curve;
- Completion of hydration.

Independently of the type of retarder, a quick setting plaster needs more retarder for a given initial setting than a slow setting plaster.

In figure 2 we show the typical efficiency curves of different kind of retarders. They show generally a non-linear course. For practical purposes if a fixed setting time is targeted, only small adjustments need to be made, we can assume a linear function.

Figure (2): Delay of initial setting as a function of dosage for different retarders. Schematic presentation of the characteristic behaviours (at pH close to 7).

Plast Retard L is the most efficient product and has a slope suitable for setting control.

2.1.2 Adjustment of setting kinetics

The setting of calcined gypsum depends upon the raw gypsum source, the calcining equipment and storage conditions. Initial setting, for instance, can vary in extremis from a few seconds to 30 minutes. Plasters for wallboard production can have a span of initial setting from 3 to 15 minutes but are always kick-started with a starter. The combined use of Plast Retard L and accelerator, if needed, helps to optimise the setting kinetic as shown in figure 3:

Figure (3): Adjustment of setting kinetics.

The initial stiffening can be postponed, far enough behind the forming ➊. The knife-point ➋ can be maintained and the final setting ➌ can be achieved in time.
2.1.3 Improvement of fluidity

The water/plaster ratio depends on the same parameters as the setting but also on the kind of mixing equipment and mixing energy absorbed. A common indicator for fluidity is the slump. It is the spread (measured in mm) of a slurry, filled in a bottomless cylinder (60 mm diameter and 50 mm height) and lifted quickly.

Plast Retard L reduces the W/P needed for a given fluidity or, as shown in figure 4, increases the fluidity for a given W/P ratio. At a dosage of about 0.015% (active matter) of plaster the saturation is reached.

The increase of fluidity is not affected by the presence of a starter, as shown in fig. (5). The base is a quick setting plaster with an initial setting of 3 min. The slurry is vigorously mixed if as for Plasterboard production 1. The addition of 0.02% of Plast Retard L 2 augments the slump and the initial setting. The addition of 0.1% starter and of 0.02% Plast Retard L does not change the fluidity but regains the early set 3.

Figure (4): Slump and initial setting as a function of the addition Plast Retard L.

Figure (5): Slump (mm) and initial setting (min’ sec”) as described above.
2.2 More about setting control in Plasterboard production

2.2.1 The role of retarders

Setting and W/P ratio can be controlled, to a certain degree, by additives. It is state of the art to combine a starter (ground raw gypsum) with Plast Retard L and an accelerator (e.g. potassium sulphate).

Every retarder acts a bit differently in regard to the setting kinetics as shown in figure 6. These differences are crucial in plasterboard production as will be shown below.

Figure (6): schematic representation of the characteristic setting kinetics induced by different retarders and different combinations of retarders, starter and accelerator, as used in plasterboard production.

The first section represents the increase of the yield stress, equivalent to a decrease of fluidity of the slurry before the initial setting. The sharp bend is equivalent to the initial setting. The more or less steep slope indicates the speed of the setting and the second sharp bend indicates the end of hydration.

In Plasterboard production a starter is always used in order to get an early complete set. But a starter causes an almost immediate initialisation of the setting which is not beneficial for fluidity, water demand and other properties of the slurry (violet curve in figure (6)).

The use of a retarder will eliminate all these problems (dark blue and green curve in figure (6)).

As can be seen, the usage of a retarder postponed the initial setting, far enough behind the forming ➊. If the final setting ➋ should be achieved earlier, an accelerator must be used. With Plast Retard L even the knife-point ➌ can be maintained.

Figure (7): Further graphs.

Remark: Plast Retard L and Citric Acid in a dosage which results in the same initial setting.

- Pure Plaster
- Citric Acid
- Plast Retard L
- Starter Alone
- Accelerator
- Starter + Citric Acid
- Starter + Plast Retard L
- Plast Retard L + Starter + Accelerator

- With Accelerator + Starter + Plast Retard L
- With Accelerator
- Pure Plaster
- With Plast Retard L + Accelerator
- With Citric Acid
- With Plast Retard L
2.2.2 The role of Starter

Starter (BMA = Ball Milled Accelerator) is an inevitable part of the plasterboard formula and it is a kind of antagonist of retarder. Therefore, the system works only as well as both elements work appropriately. Starter is a finely ground gypsum (Dihydrate) which acts as a source of crystallisation germs. Traces of Dihydrate are often present in plaster in variable amounts.

They are the main reason for the variability of the setting times of a given plaster product. Thus, BMA has the double role of obliteration, by overdose, the natural variability of traces of germs and to reduce the time needed for the completion of the hydration.

SECTION 3

SPECIFIC PRODUCT INFORMATION

3.1 Typical composition and properties

<table>
<thead>
<tr>
<th>Physical form:</th>
<th>Brown coloured liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active substance:</td>
<td>43 - 45 % w/w</td>
</tr>
<tr>
<td>Water content:</td>
<td>55 - 57 % w/w</td>
</tr>
<tr>
<td>Solubility in water:</td>
<td>total</td>
</tr>
<tr>
<td>pH relative to 10% w/w solutions:</td>
<td>7 - 8,5</td>
</tr>
<tr>
<td>Density:</td>
<td>1,22 - 1,25 g/ml</td>
</tr>
<tr>
<td>Viscosity:</td>
<td>21 cPoise</td>
</tr>
<tr>
<td>Shelf life:</td>
<td>3 years (if kept sealed, in its original packaging)</td>
</tr>
</tbody>
</table>

Plast Retard L is carefully produced and controlled in our laboratories at every step of production in order to assure a standardized product.

3.2 Usage levels

Plast Retard L can be used in any type of natural or by-product gypsum (e.g. from flue gas desulfurization, phosphoric acid, citric acid, titanium dioxide), both low and high quality and at any water/gypsum ratio.

Plast Retard L is effective at a pH range comprises from 5 to 12 and its maximum efficiency is between 7 and 10 (Figure 8). The pH where plasterboard and other pre-fabricated products are manufactured lies in the centre of effectiveness.
3.3 Compatibility

Generally, Plast Retard L is used alone in gypsum formulations but it is totally compatible with other retarders. It is also compatible with most active additives generally used in formulations. The only known incompatibility is with soluble Aluminium salts, which are not common in Plasterboard production.

SECTION 4

HANDLING, STORAGE AND METERING

Plast Retard L does not contain preservatives and it is stable when stored in its original packaging at temperatures that range from 4°C to 30 °C.

If diluted with water and stored over days, Plast Retard L might turn a bit gelatinous, thus it is advised against the dilution of the product.

Metering is best done in undiluted form into the main water feed using a one-way valve in order to resist to the back pressure. The most appropriate pump to be used is a Mohno-pump (screw pump). Figure 9.

Figure 9: a scheme for a metering device as proven in many plants.
TOXICOLOGY/ REGULATORY/ HEALTH, SAFETY AND ENVIRONMENT

Toxicology: On the basis of the results, obtained according to OECD n° 420 dated 17th December 2001, Plast Retard L is included in the category 5 of the GHS classification and consequently is NON TOXIC. On the basis of the results and according to Italian Ministerial Decree dated 28th of April, 1997, Plast Retard L is classified NOT IRRITANT FOR EYES AND SKIN. Plast Retard L can therefore be handled following reasonable safety precautions and good manufacturing practices.

Ecology:
On the basis of the obtained results, according to the screening method and guidelines reported in OECD n° 301/1992 and ISO 14593/1999 to which CE 648/2004 concerns, Plast Retard L is biodegradable under aerobic conditions.

No special regulations apply to the transportation of Plast Retard L.

SUMMARY - Why using Plast Retard L

1) To have maximum effect with minimum dosage;
2) To define a precise and predictable hydration point. This results in a higher control on the exact position of the knife point.
3) Since Plast Retard L provides a certain fluidizer effect, you will get a reduction (about 5%) in the quantity of water needed in the pin mixer and then:
   a) The saving in water directly translates to a proportional saving in the drying cost;
   b) Reducing water increases the plant capacity.
4) Plast Retard L is a reliable cleaner inside the pin mixer. This will result in a reduction in little lumps formation and imperfections of Gypsum coming from the pin mixer. This enables longer running time of your line because there is a longer period between the cleaning of the pin mixer.
5) To increase the homogeneity of the board.
6) To obtain better edge profiles of the board showing then a more stable shape.
7) Unlike other retarders present in the market, Plast Retard L does not contain any hazardous substances.