®Mowilith LDM 7255 for Film Print Lamination

Contents

1. Abstract

Film print lamination is used to protect printed paper and cardboard and to provide an elegant look to such substrates, by laminating a thin plastic film on the printed substrate. Water-borne adhesives can be applied by different lamination techniques, of which the "dry" and "wet" lamination processes are the most important ones. Vinyl acetate copolymer dispersions can be used for the wet lamination process. Suitable are VAE copolymers e.g. ®Mowilith DM 132, DM 1330 and if requirements are less demanding also ®Mowilith DS 5 can be used. For the dry lamination process ®Mowilith LDM7255 – a pure acrylic dispersion – is the product of choice. Important properties of ®Mowilith LDM 7255 are discussed. Guide formulations for one-component and two-component adhesives based on ®Mowilith LDM 7255 are given. Possible modifications of ®Mowilith LDM 7255 to improve properties of one-component systems are mentioned, e.g. addition of PU-dispersions, harder pure-acrylic dispersions or solvents.

2. Film Print Lamination – Processes

Film print lamination is widely used in fields where printed paper or cardboard has to be protected against humidity, intensive light exposure and fats and / or where an elegant surface look (e.g. high gloss, but also matt) is required. Main application areas are: picture postcards, protective coatings on didactical tables, book coverings, advertising materials and packaging materials for luxurious goods.

In the process a printed paper or cardboard substrate is laminated with a thin plastic film that determines the final surface properties. Suitable plastic materials are e.g. bi-axially oriented polypropylene (BOPP) and cellulose acetate. Film thickness is depending on the required properties. Normally, a thickness in the range of 10 – 20 µm is used.

World-wide still mostly used for these laminations are solvent-based adhesives, but solvent-free and water-borne systems are gaining market share. Chemically, the solvent-based, but also the solvent-free adhesives are one- or two-component PU-systems.

Major drawbacks of solvent-based adhesives are:

- emission of solvent vapours
- higher consumption of adhesive
- no immediate processing after lamination possible and
- flammability

Therefore, nowadays water-borne adhesives are getting more and more attractive.
There exist quite a number of different lamination technologies. However, for water based systems only two of these are of major importance. These are the so called “wet lamination process” and the “dry lamination process”. The main features of these two processes are summarised in table 1.

	Wet Lamination	**Dry Lamination**
Dispersion	coarse/medium particles high solids content	fine particles low viscosity
Application by	e.g. doctor blade, roller coater or others	
onto	printed substrate	plastic film
Amounts applied	approx. 20 g/m² dry	6-8 g/m² dry
Drying in machine	no drying	drying at 70°C
Laminating calander	room temperature	80 °C
Further processing	possible after drying	directly possible

Table 1: Technologies for Film Print Lamination

3. Requirements for Water-Borne Adhesives and Suitable Dispersions

General requirements for adhesives used in film print lamination are the following:

- formation of colourless transparent films (after drying)
- good adhesion on printed paper/cardboard and film: resistant to bending and embossing
- sufficient cohesion of the laminate: resistant to embossing and heat
- good ageing and UV-stability of the laminates
- high brilliance of laminated colour prints (if high gloss films are used) and
- sufficient resistance against residual solvents (from the printing inks)

Further requirements depend on the application process. Some of the most important ones for wet and dry lamination are summarised below:

Wet Lamination

- high solids content of the dispersion for fast drying at room temperature (advantage compared to solvent-borne systems)
- viscosity of the dispersion in medium range (e.g. 3.000 – 5.000 mPa.s; Brookfield, RVT) for doctor blade application)
- particle size medium-coarse to avoid too fast absorption by the substrate
- good wetting on print and film combined with good wet tack of the adhesive

Out of Clariant's product range VAE dispersions like ®Mowilith DM 132, DM 131 and DM 1330 can be used as binder for wet lamination. In countries where VAE grades are not available and requirements are less demanding, the use of another copolymer grade (e.g. ®Mowilith DS 5) is possible. The dispersion can be modified with plasticiser, solvent and other dispersions with a low glass transition temperature (Tg).

Dry Lamination

- low viscous dispersion (actual viscosity needed depends on application system)
- good spreading of the adhesive on plastic films without wetting defects
- fast drying at temperatures of approx. 65 - 75 °C on common laminating machines
- lamination should be possible by use of a calander at 80 °C (max.)

For dry lamination Ò**Mowilith LDM 7255** is the product of choice.

4. Adhesive for Dry Lamination – ÒMowilith LDM 7255

®Mowilith LDM 7255 approx. 55% is a plasticiser-free aqueous dispersion based on acrylic and methacrylic acid esters. The dispersion meets the compositional requirements of the recommendation of BgVV XIV (food packaging). Its properties are summarised in the table below:

	Value
Solids Content	approx. 55
Viscosity (Brookf. RVT, sp. 3/ 20 rpm, 23 °C)	approx.1 000mPa.s
pH	approx. 7.0
Particle Size	approx. 0.1- 0.25 µm
Tg (DSC, heating rate: 10 K/min, midpoint)	approx.-20 °C

Table 2: Properties of ® Mowilith LDM 7255

®Mowilith LDM 7255 is suitable as binder for the formulation of adhesives for continuous dry film lamination as one- or two-component system. The polymer film of the dispersion shows good adhesion properties towards plastic films (also towards pre-treated Polypropylene) and printed substrates, even at temperatures down to –18°C. The dispersion has a high agitation and shear stability and can be applied by roller coater, doctor blade or air-brush coating equipment. The dispersion dries very fast. Drying of the dispersion can be slowed down by increasing pH to 7.2 - 7.5 by adding sodium hydroxide solution (5%).

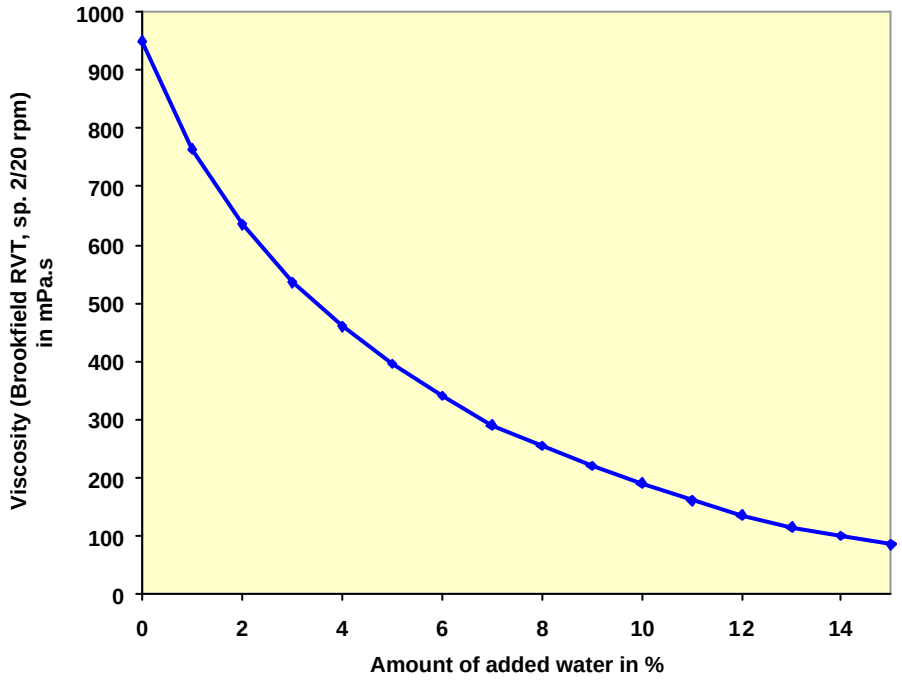

Figure 1: Viscosity of ® Mowilith LDM 7255 after addition of water

In principle, ®Mowilith LDM 7255 can be used without further modification, just diluted with water to the required viscosity (compare dilution curve in fig.1). Like many other pure acrylic dispersions ®Mowilith LDM 7255 is quite sensitive against surface-active additives like wetting agents and antifoam. Thus, whenever possible, the addition of such surface-active compounds should be avoided. However, if necessary, the materials mentioned in the guide formulations for one-and two-component adhesives (see below) can be used in the concentration range given there. Other wetting agents or antifoams have to be checked regarding compatibility. Incompatible additives can cause wetting defects such as craters and fish-eyes.

4.1 One-Component System

A guide formulation for a one component adhesive based on ®Mowilith LDM 7255 is given below:

99.5	pbw	®Mowilith LDM 7255
0.3	pbw	®Surfynol 104 E (wetting agent; supplier: Air Products)
0.2	pbw	®Foamstopper 602 (antifoam; supplier: Harco)
X	pbw	of a 5% solution of sodium hydroxide (NaOH) to adjust pH to approx. 7.2 – 7.5
Y	pbw	water to adjust viscosity to the required value (e.g. 200 - 300 mPa.s)

4.2 Two-Component System

In some cases, higher cohesion (corresponding with higher peel strength) is required for special post-treatments of the laminates like embossing. The cohesion of the lamination bond can be improved, if necessary, by the addition of isocyanate crosslinker suitable for water borne adhesives. Compatibility, efficacy, and pot-life of the resulting two component adhesives should be examined previously. In general, an amount of 3-5 % of active isocyanate (based on the adhesive) should be sufficient. The hardener should be added directly before use. For a easier homogenisation, the hardener may be diluted with an aprotic, non-reactive solvent.

A guide formulation for a two component adhesive based on ®Mowilith LDM 7255 is the following:

99.5	pbw	®Mowilith LDM 7255
0.3	pbw	®Surfynol 104 E (wetting agent; supplier: Air Products)
0.2	pbw	®Foamstopper 602 (antifoam; supplier: Harco)
X	pbw	of a 5% solution of sodium hydroxide (NaOH) to adjust pH to approx. 7.2 – 7.5
Y	pbw	water to adjust viscosity to the required value (see 4.1)
3.0	pbw	®Bayhydur 3100 (supplier: Bayer)

The pot-life of such a two-component adhesive is at least 6 hours (at 23 °C). The viscosity of the hardener-containing mixture stays constant, also after the end of pot-life (see figure 2).

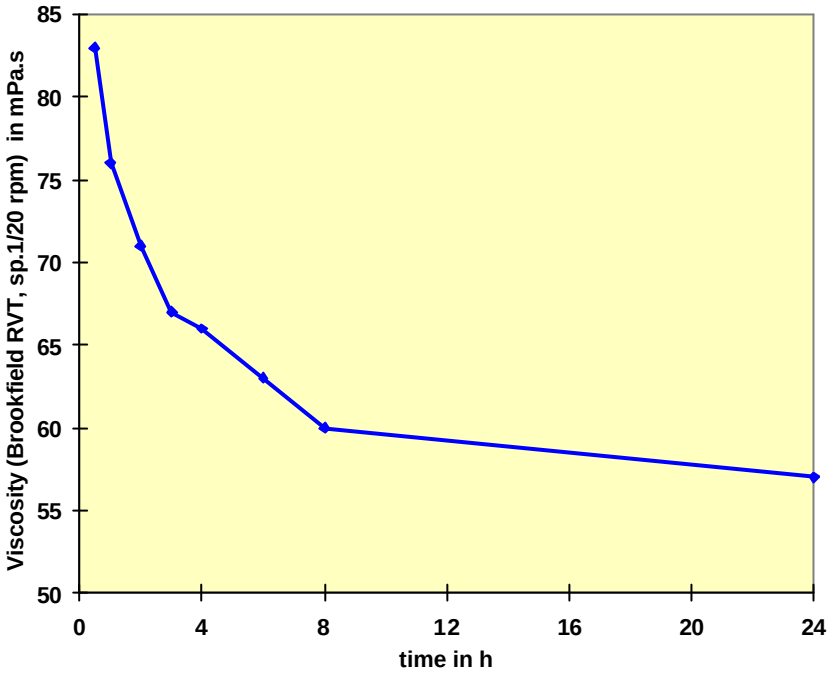

Figure 2: Viscosity of two-component adhesive after addition of ®Bayhydur 3100

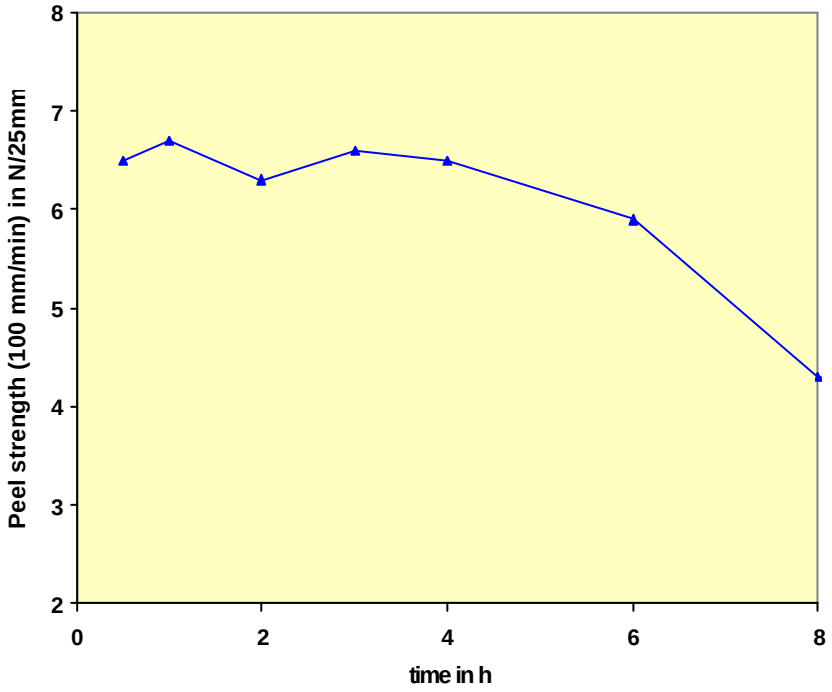

Figure 3: Peel strength as function of time after addition of ÒBayhydur 3100

As indicated in figure 3, the peel strength of the laminate decreases towards the end of pot-life down to the level of a one-component system (2-3 N/25 mm). After end of pot-life the two component adhesive can be re-used as a one-component system. It is recommended to add the filtered adhesive to fresh one-component adhesive in amounts up to 25%.

5. Possible Modifications of Ò Mowilith LDM 7255

Improvement of Peel Strength

Peel strength of the laminate can be improved to some extent by blending ® Mowilith LDM 7255 with dispersion types like PU's.

Special PU-dispersions like ® Dispercoll U53 (supplier: Bayer) possesses very good cohesion properties in laminations. However, if applied as sole binder non-transparent films result. Tests with mixtures of ® Mowilith LDM 7255 with ® Dispercoll U53 have shown, that peel strength and heat resistance of the laminate (see figure 4) can be increased without getting turbid films. However, the amount of ® Dispercoll U53 should not exceed 20 pbw (based on ® Mowilith LDM 7255).

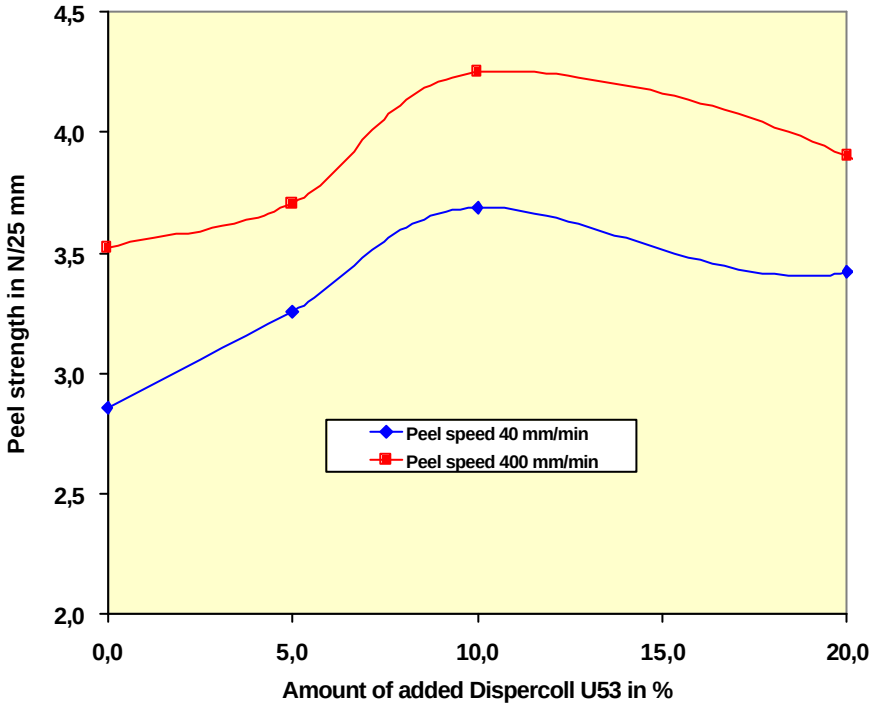

Figure 4: Peel strength of laminates depending on the content of Ò Dispercoll U53

Improvement of Film Hardness

In some case, there is a wish for harder adhesive films in order to improve cutting of the laminates at elevated temperatures, where sometimes soft films tend to stick to the cutting knifes. This can be achieved to some extent by blending ®Mowilith LDM 7255 with harder acrylic dispersions, e.g. ®Mowilith DM 777 (Tg = 24 °C) which shows good compatibility. If other grades should be selected, special attention should be paid to turbidity and wetting defects. The amount of added ®Mowilith DM 777 should not exceed 10 pbw based on ®Mowilith LDM 7255. A higher content of ®Mowilith DM 777 is causing a drop in peel strength (see figure 5) due to weaker adhesion towards the polypropylene foil.

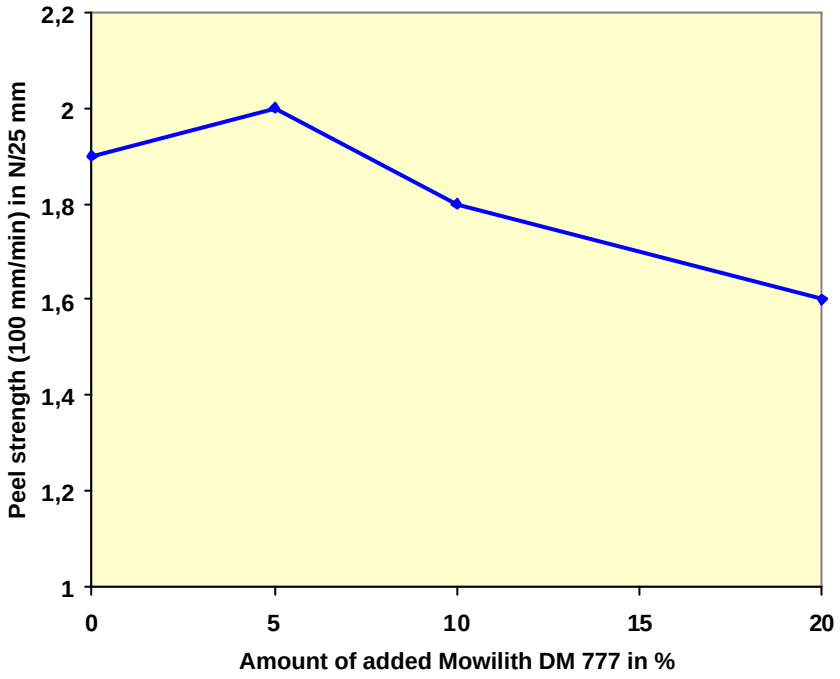

Figure 5: Peel strength of laminates depending on the content of ®Mowilith DM 777

Improvement of Adhesion

Adhesion towards critical substrates can be improved by adding small amount of high boiling solvents, e.g. butyl diglycol acetate (1 pbw based on adhesive).