ASSOCIATIVE POLYURETHANE THICKENERS FOR AQUEOUS COATINGS

Rheological behaviour precisely adjusted to application!

In this narrow and highly specialised business area the coating materials must be processed optimally. The desired film thickness should be achieved with simple application and good levelling in one operation. For wall paints often the first impression during stirring is of importance. But also low spattering and sufficient stability has to be precisely adjusted to distinguish clearly from competitive products

Paints are used to achieve additional surface functions. The application spectrum ranges from traditional surface protection against aging and corrosion to special visual or functional properties, such as complex metallic coatings in automotive industry or self-cleaning surfaces. A great deal of work is put into the development of paints to obtain protective, optical or functional properties. However, in the course of development the rheological behaviour of the coating is often neglected, although it affects its entire life cycle including manufacturing, storage up to easy application by the end user (see photo above).

Often the viscosity of a coating is adjusted to a desired level with one standard thickener at a specific shear rate only, usually with flow times from the ISO cup or with rotational viscometers. The rheological profile of paints however cannot be adjusted sufficiently this way. Viscosities at different shear rates have very different technical implications in the life cycle of a coating (Figure 2).

A complete rheology profile can be recorded with expensive rheometers only. Therefore they are still not available in all research laboratories.

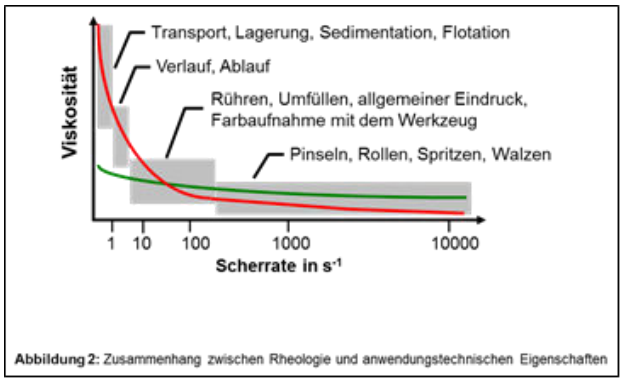

Abbildung 2: Zusammenhang zwischen Rheologie und anwendungstechnischen Eigenschaften

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In general the classic thickeners based on cellulose and acrylates have strong pseudo plastic rheology profiles. The thickening mechanism is based on long, entangled molecular structures. Due to their voluminous chemical structure they are thickening the aqueous phase. These thickeners show good sagging resistance, but often it is associated with poor flow and high elasticity and causing spattering. Additionally water resistance is adversely affected; this is especially important for anti-corrosion coatings.

TAFIGEL™ PUR - Associative Polyurethane Thickeners

The thickening mechanism of associative polyurethanethickeners (HEUR) is completely different. Due to their hydrophobic-hydrophilic-hydrophobic structure they form aggregates in aqueous systems (micelles), whereby f.e.one thickener molecule can be part of two or more micelles and in this way they are physically linked. The hydrophobic end groups of several thickener molecules are forming these bridged micelles with each other. Beyond this they interact with the hydrophobic surfaces of the binder dispersion or with other hydrophobic ingredients of the formulation. This association causes the immobilization of the formulation components and results in thickening (see figure 3)

Under shear the associative network between the polyurethane thickeners and the hydrophobic components of the systems – mainly the binder– is temporarily destroyed.

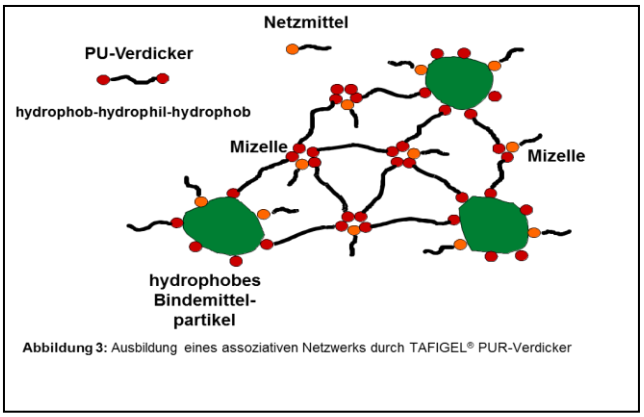

Figure 3: Formation of associative network with TAFIGEL ® PUR thickener

Tabelle 1: Molekulargewichte ausgewählter Farb-Additive

Additiv [g/mol]	Molekulargewicht
Netzmittel/Emulgator	~ 102
Dispergiermittel	~ 103 - 104
Polyurethanverdicker	~ 104
Acrylatverdicker	~ 105
Zelluloseether	~ 106

Table 1: Molecular weight of selected coating additives

Once shear energy is taken away the associative network rebuilds after a short time, therefore levelling properties are much better than with classic cellulose or acrylic thickeners.

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In the same way polyurethane polymers are able to stabilize other hydrophobic and hydrophilic components of the formulation. The hydrophobic as well as the hydrophilic polymer segments of the thickener can interact with pigments and can provide additional wetting and dispersing effects. By the interaction with pigments and fillers the colour acceptance in tinting is increased, settling tendency and rub-out problems are reduced.

In general the molecular weight of polyurethane thickeners is significantly lower than the molecular weight of other thickener types such as acrylic thickeners and cellulose ether (Table 1).
Combined with the lower elastic properties this leads --in comparison to cellulose ethers- to significantly decreased spattering tendency of dispersion paints (Figure 4)

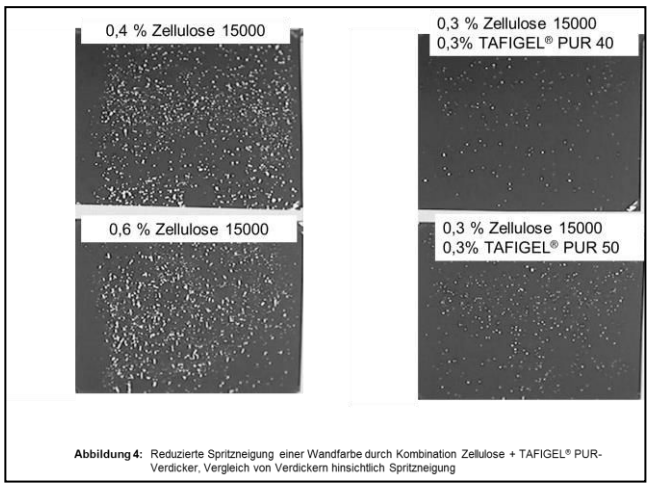

Abbildung 4: Reduzierte Spritzneigung einer Wandfarbe durch Kombination Zellulose + TAFIGEL® PUR-Verdicker, Vergleich von Verdickern hinsichtlich Spritzneigung

Reduced spattering tendency of an architectural coating by combinations of cellulose and TAFIGEL™PUR thickeners; comparison of thickeners regarding spattering tendency.

The chemical design of the "hydrophobic-hydrophilic-hydrophobic" segments allows to vary the associative behaviour of the polyurethane thickeners and to adjust the desired rheology profile within a wide range (se figure 5).
For example: weak hydrophobic end groups and longer polymer chains tend to lead to Newtonian flow behaviour , like in TAFIGEL ™ PUR 45 and TAFIGEL ™ PUR 80 . In this way the viscosity at high shear rates can be targeted increased. With these thickeners excellent levelling, high gloss and the so-called brush drag are obtained, which means, that the paint transfer with a single brush stroke is increased.

With strong end groups and short polymer chains (like in TAFIGEL ® PUR 60 and TAFIGEL ® PUR 61) strong pseudo plastic rheology profiles can be obtained. Emulsion paints adjusted with these rheology modifiers have high sagging resistance and excellent spray ability. A typical application is, for example, the industrial thick layer spray coating for door and window frames.

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Medium pseudo plastic polyurethane thickeners like TAFIGEL ™ PUR 40 or TAFIGEL ™ PUR 41 have universal rheology profiles. They can be used for brush, roller and for spray applications. They develop their particular strength in combination with cellulose thickeners in wall paints. While the cellulose derivative provides the required open time, TAFIGEL ™ PUR improves levelling and reduces drastically spattering, for example, at brisk roller application.

Table 2 gives a selection support for thickener types to be used in various applications for construction and industrial sectors.

Thickener selection guide for different architectural and industrial applications:
Table 2:

Application	**Recommention**
Brushing	TAFIGEL ™ PUR 40, 41, 45, 80
Rolling	TAFIGEL ™ PUR 40, 41, 45, 80
Spraying	TAFIGEL ™ PUR 60, 61
Dipping	TAFIGEL ™ PUR 60, 61
Flow/curtain	TAFIGEL ™ PUR 40, 41, 45, 80
Rolling/ printing	TAFIGEL ™ PUR 40, 41, 45, 80

Desired coating properties	**Recommendation**
Gloss	TAFIGEL ™ PUR 45, 80
Sagging resistance and storage stability:	Cellulose, TAFIGEL™AP, TAFIGEL ™ PUR 60, 61,
Open time	Cellulose

Special systems	**Recommendation**
PU, EVA Binders	TAFIGEL ™ PUR 60, 61, TAFIGEL ™ AP
Silicone resins	TAFIGEL ™ PUR 45, 80
Anti-corrosion	TAFIGEL ™ PUR
„Flop“-effect with metallic coatings:	TAFIGEL ™ AP

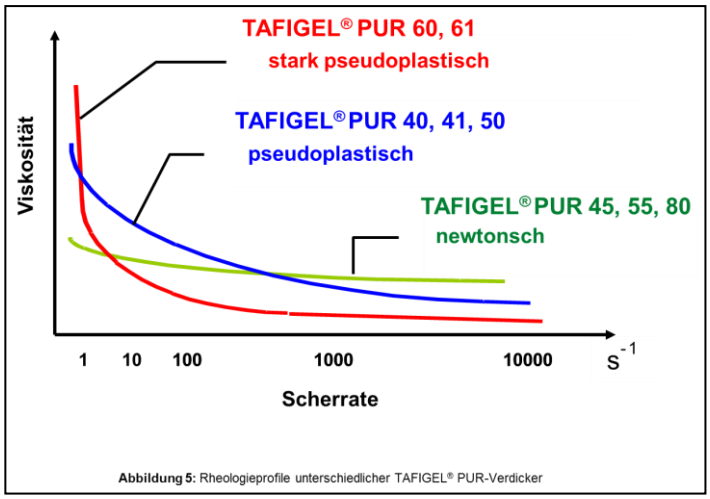

Figure 5: Rheology profile of different TAFIGEL ™ PUR thickeners.

Summary:

The associativee polyurethane thickeners can be combined easily with each other as well as with all known thickeners types, often with synergistic effects. Their major strengths are the specific adjustable rheology profiles. They have better levelling properties than classical thickeners and higher gloss levels are achievable. The higher water and scrub resistance

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and the higher resistance against bacteria are further advantages. Open time and storage stability can be improved by a clever combination with cellulose thickeners.

The selection of a suitable thickener depends crucially on the scope and application technique. By proper selection and clever combination the rheological behaviour can be adjusted appropriately and user-friendly. In a more and more competitive environment this is an ideal way of: Creating Additive Value!

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