WHITE PAPER

Past and Future of Universal Colorants in Coatings

Frank Kleinsteinberg, Evonik Resource Efficiency, Germany

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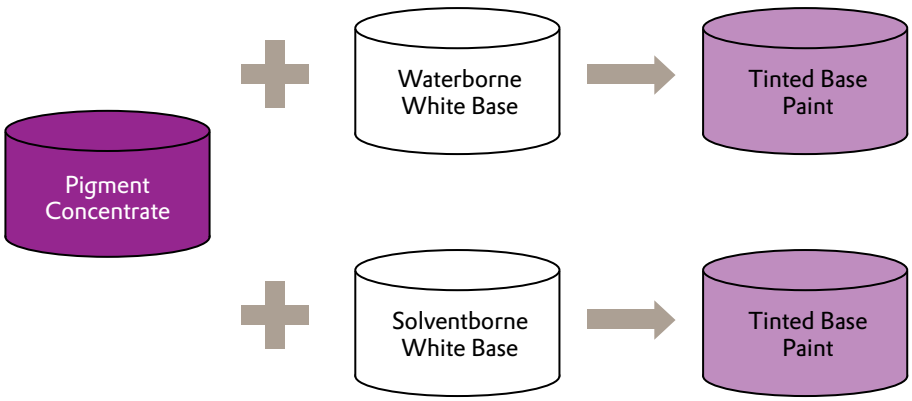
INTRODUCTION AND DEFINITION

Universal colorants can be defined as waterborne colorants for the tinting of waterborne decorative paints (e.g. acrylics, PVAc, low and high PVC paints) and solventborne decorative paint formulations (e.g. long oil alkyds). (Fig.1)

Fig. 1: Usage of universal colorants

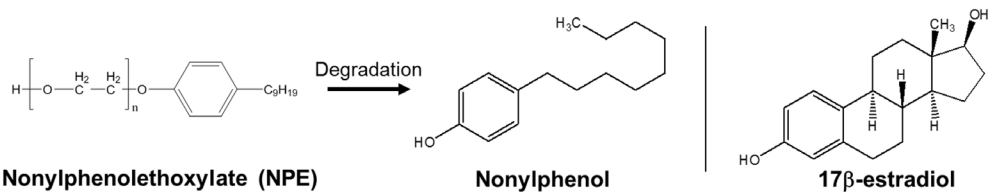


BASIC FORMULATION PRINCIPLES

In the past and even up until now, APEs are used to produce universal colorants.
The APEs used in the coatings industry are often nonylphenol ethoxylates (NPEs) with a degree of ethoxylation between 5 and 10. [4] The main degradation products are the corresponding nonylphenol and ethylene glycol. Due to their persistence (further biochemical degradation to methane, carbon dioxide and water proceeds very slowly) nonylphenols will accumulate in sediments of polluted water. [5]

Nonylphenols, even at very low concentrations, are toxic to aquatic organismsas their estrogen-like structure; in figure 2 they are compared with 17β-estradiol, emulates this most effective female hormone [1, 6-11]. Therefore, nonylphenols – the degradation products of NPEs – intervene in the fertility cycles of organisms, as proven for fish and mammals. The hypothetical impairment of human reproduction is not yet proven [12].

Fig. 2: Nonylphenol in comparison to 17β-estradiol

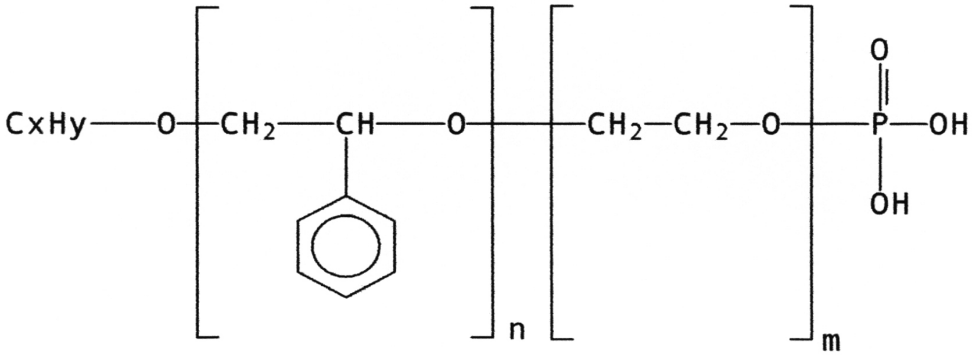


Because of the problems mentioned above, a concerted effort to reduce the volume of NPE's used in industry and in universal colorants is being made.

Apart from common fatty alcohol alkylene oxides [4, 14, 15] special GUERBET derivatives [16] have been promoted as suitable NPE alternatives. In the meantime these fatty acid derivatives developed to a chemical class that could replace APEs in universal colorants in terms of suitability.

Another successful replacement for NPE are special polyether phosphates. These polyether phosphates can even extent the usage of universal colorants to façade coatings and silicate formulations. (Fig. 3) [2]

Fig. 3: Polyether phosphate to replace APEs



PRESENT SOLUTIONS FOR COMPATIBILITY

A critical time for universal colorants became the year 2010. The new directive for decorative paints reduced the VOC-content of alkyd paints to a limit of 300 g/L. New binders and new formulations were necessary and the compatibility with old universal colorants was significantly reduced. The main issue is the high water content of modern universal colorants that leads to an increase of viscosity and a low compatibility. (Fig. 4 and 5)

Fig. 4: Viscosity increase after tinting

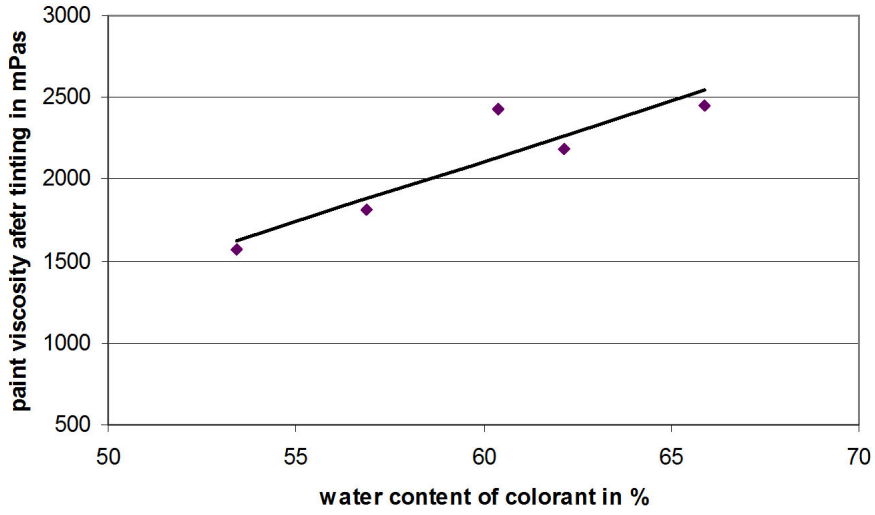
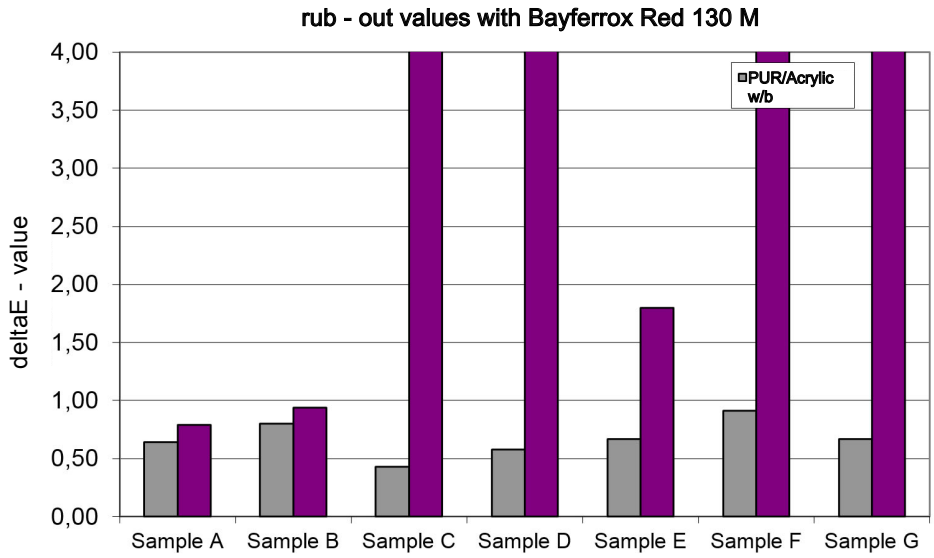
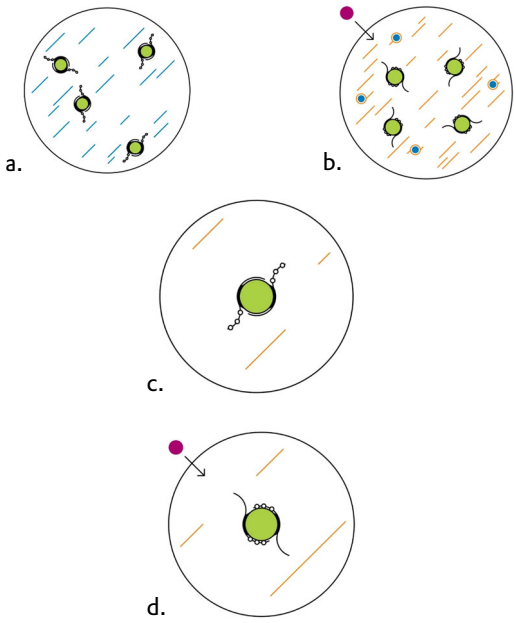


Fig. 5: Compatibility of universal colorants in modern paints



During tinting of solvent borne formulations the water containing universal colorant should form small droplets that can then be easily distributed in the solvent phase. In order to keep the universal pigment concentrate stable, the ethoxy/hydrophilic part of the dispersing agent is deployed to accommodate the stability in the aqueous medium, whereas the hydrophobic arm of the dispersing agent stays inactive.(Fig. 6a) However, when introducing this pigment concentrate into the solvent based alkyd-system a reversal of the activity of the respective hydrophilic and hydrophobic part of the dispersing agent is desired.(Fig. 6d) This can achieved by dissipating the water of the pigment concentrate evenly into the continuous phase of the paint (Fig. 6b), allowing the hydrophic part of the dispersing agent to now inflate and thus foster the stabilization of the pigment in the hydrophobic solvent media. (Fig. 6)

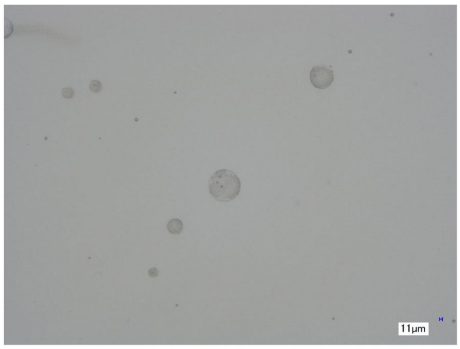
Fig. 6: Mode-of-action of compatibilizers (symbolized by purple dot) in alkyd paints



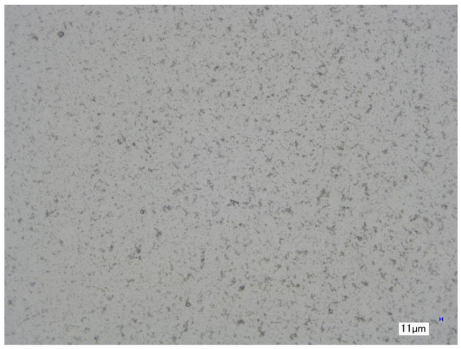
The key for successful result of this complex mechanism seems to be the distribution and emulsification of water. High solid alkyd formulations sometimes need help with the emulsification of water. In this case, water-in-oil emulsifiers might be useful. To observe the mode-of-action the water distribution within an Alkyd Base was analysed with different microscopic pictures. On the first pictures you see the difference in water droplets between an alkyd base paint with and without compatibilizer. With a post addition of 1% compatibilizer the picture shows a much better distribution of the water droplets. This leads to a better distribution of the pigment concentrate in the alkyd base paint as seen in the second picture.

Fig. 7: Microscope pictures of a) water added to an alkyd base paint , b) colorant added to an alkyd base paint

1% water added to Alkyd-Base

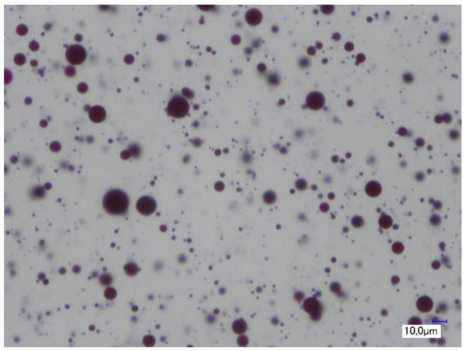


without compatibilizer

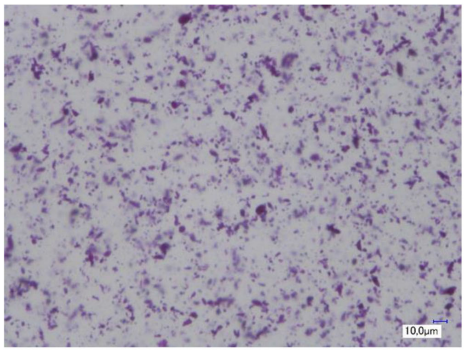


with compatibilizer

1% pigment paste added to clear Alkyd-Base



without compatibilizer



with compatibilizer

A drawback of these emulsifiers is the influence on the overall coating properties. Especially an increase of viscosity or drying time can be seen here. To overcome these hurdles, Evonik Resource Efficiency developed new amidoamine-structures that combine a good efficiency with a low influence on coating properties like viscosity and drying time.

TEST RESULTS WITH COMPATIBILIZERS

Improved Color Strength and reduced deltaE values

A commercially available alkyd base paint (HS formulation, aromatic-free) was tinted with commercial available universal colorants. The tested compatibilizing structures were added to the base. The mixing was done for 1 min at 2000 rpm by Speedmixer TM. A draw-down on a Leneta Card was prepared and a part of the film has been rubbed just before drying (rub-out). Delta E of the rub-out and the color strength were measured. The results can be seen in Fig. 8.

Fig. 8 a) PR 101 universal colorant in White Alkyd Base

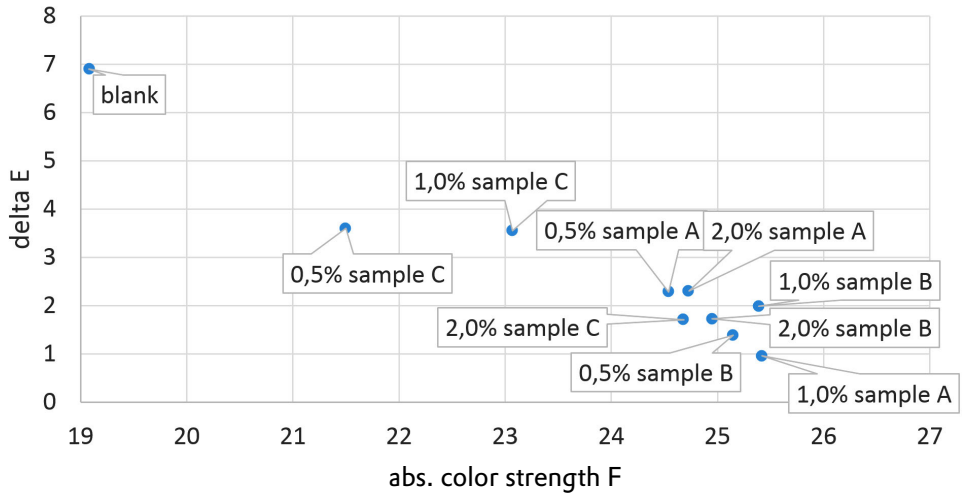
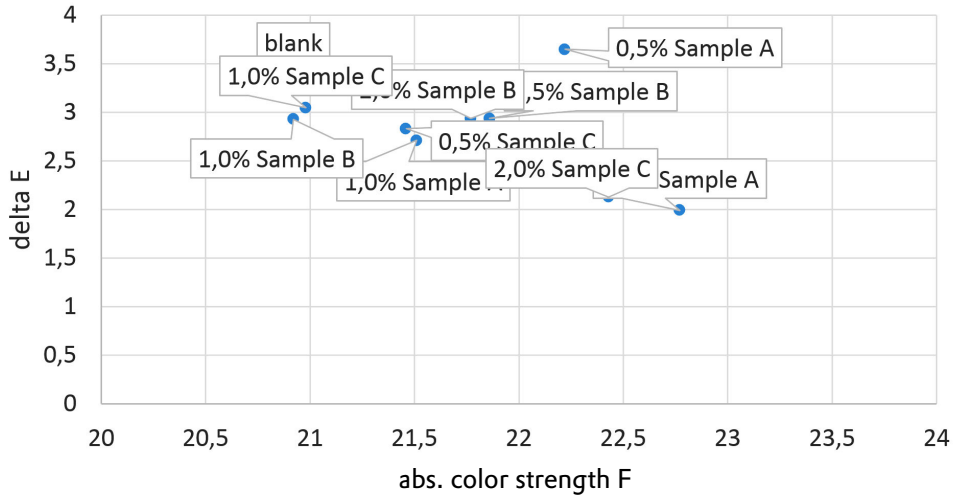


Fig. 8 b) PB 15:3 universal colorant in White Alkyd Base



INSIGNIFICANT INFLUENCE ON VISCOSITY OF THE TINTED PAINTS

3% of the tested structures were added to the base and after 24 hours of rest and several weeks storage at 40°C the viscosity was measured. The results in Fig. 9 show the good results of the tested structures.

Fig. 9: Viscosity of the base paint during storage

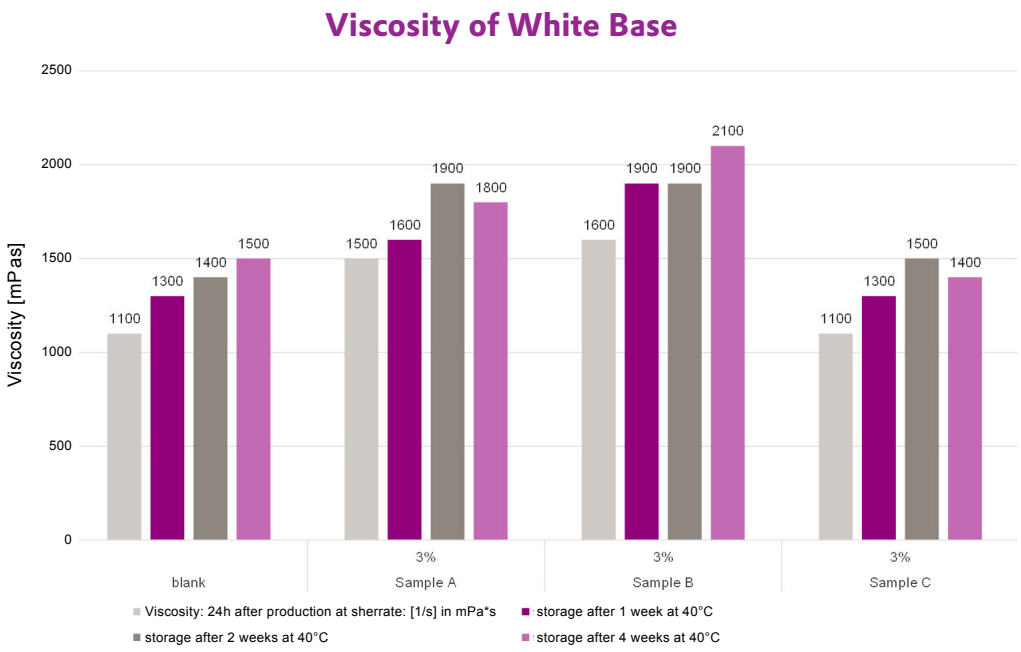
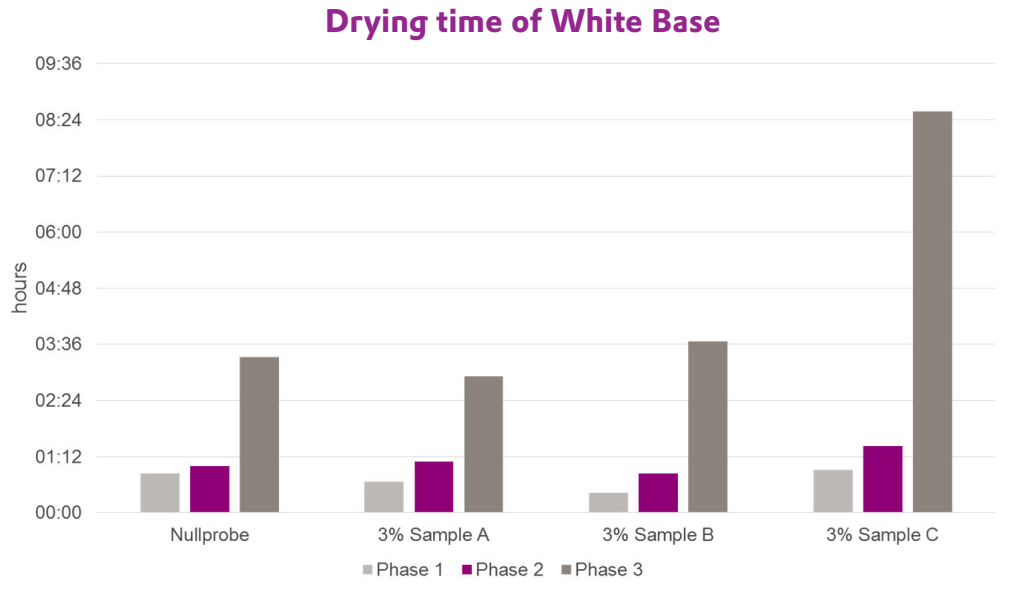


Fig. 10: Drying time of base paint



In addition to that the drying time of the base paints was recorded by drying recorder.
Fig. 10 shows the good results of structure A and B.
The increase in drying time with Structure C was not acceptable.

SUMMARY OF TESTS FOR PAINT PERFORMANCE

Overall, the results show that the new amido-amine structures can improve the color acceptance of universal pigment concentrates in alkyd base paints without impairing the more important coating properties. This development should be able to broaden the market for universal colorants, while maintaining the strikt regulations of VOC content.

FURTHER OUTLOOK

Another logical step to broaden the market for universal colorants would be the usage in industrial coatings. Up to now, the content of water is the reason for their usage limited to decorative paints. The containing water would interfere in the hardening mechanism of many industrial coating formulations. A universal colorant without water is possible and might be the future of universal colorants. The range of possible raw materials has been determined already that combine broad compatibility with the needed resistance properties for industrial coatings.

LITERATURE

[1] David Schmedding, Vickie L. Tatum,
International Environmental Conference & Exhibit 1998

[2] A. Stüttgen, K. Lehmann, ECS 2001

[3] Helena Harvilicz, Detergents & Personal Care No. 14 (2000) Vol 257

[4] J. Bielmann, PPCJ 3 (1995), 17

[5] APE Research Council

[6] K. Fent, Swiss Federal Institute for Environmental Science and Technology

[7] Björn Thiele, Klaus Günther, Milan J. Schwuger, Chem. Rev. 97 (1997), 3247

[8] P. Schöberl, K. J. Bock, L. Huber, Tenside Surfactants Detergents 25 (1988) 2, 86

[9] Charles A. Staples, John Weeks, Jerry F. Hall, Carter G Naylor,
Environmental Toxicology and Chemistry, Vol. 17 (1998), 2470

[10] Alison C. Nimrod, William H. Benson,
Critical Reviews in Toxicology, 26(3) (1996), 335

[11] Björn Thiele, Klaus Günther, Milan J. Schwuger, Chem. Rev. 97 (1997), 3247

[12] Phänomen Farbe 4 (1999), 26

[13] Tenside Detergents 23 (1986) 3

[14] H. Frommelius, Tagungsband VILF 2000, 41

[15] L. Mattheus, J. Grade, 3rd International Conference ACT'98, Paper No 31

[16] Isofol, Condea Firmenbroschüre

[17] P. Quednau, P. Dijkstra, 3rd International Conference ACT'98, Paper No 29

[18] W. Heilen, A. Stüttgen, Eurocoat (Mailand 1997)

[19] G. Jaumann, E. Keck, M. Köhler, G. Uphues, Anneliese Wilsch-Irrgang, W. Winkle,
Fat Sci. Technol. 10 (1990), 389

[20] Anthony J. O'Lenick Jr., Jeffrey K. Parkinson, Surfactants 11 (1995) Vol 27, 17

[21] W. Schröder, W. Ruback, Tenside Surf. Det. 31 (1994) 6, 413

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AEROSIL®/ACEMATT®
Evonik Resource Efficiency GmbH
Rodenbacher Chaussee 4
63457 Hanau
Germany
Phone +49 6181 59-12532
Fax +49 6181 59-7112532
ask-si@evonik.com

TEGO®
Evonik Resource Efficiency GmbH
Goldschmidtstraße 100
45127 Essen
Germany
Phone +49 201 173-2222
Fax +49 201 173-1939
info-tego@evonik.com

SURFYNOL®/DYNOL™/ AIRASE®
Evonik Materials Netherlands BV
Kanaalweg 15,
3502 GD Utrecht
Netherlands
Phone +31-30-2857100
apcse@evonik.com

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