COLOR AND APPEARANCE DIVISION

NEWSLETTER

Vol.27/No.2 August, 1995
Summer

CHAIRMAN’S CORNER

Summer is here (I can tell, Central Ohio has had its annual three days of sunshine). This means the completion of another successful year for the CAD and a changing of the guard. Our thanks to Tom Pfeiffer and Gordon Gavin for their leadership and guidance of the CAD and TPC, respectively. Also, thanks to those board and TPC members that left us at the end of the year (Is this a question of common sense?): Paul Szilvagyi and Craig Weadon. Your hard work is much appreciated.

I want to welcome the newly elected members of the BOD and TPC, Rick Addis, Joe Cameron, Jeff Davis, Walter Martin, Johnny Suthers, Brian West and Jack Gormley. May your sentence be an enjoyable and pleasurable experience.

As always is true for this time of year, we have condemned another member to the role of officer. Congratulations to Bruce Mulholland on his election to TPC Secretary and to the other TPC and BOD members who moved up in the hierarchy.

Finally, one of the concerns that the BOD and TPC is addressing is the number and quality of papers being presented at our Antec sessions. The CAD has an excellent reputation within the SPE for organizing and presenting high quality Retecs. However, we continually struggle to find enough good quality papers to fill the two sessions at Antec. The CAD is asking your consideration in presenting a paper at the next or a future Antec. These papers do not necessarily have to concern new or proprietary technology. Recall that we are an educational society. Some of the best papers I have heard concerned technology or tests which are traditional and widely used throughout our industry. This is your division. It will be as successful as you are willing to make it.

Get involved; present a paper (BOD and TPC members are standing by to take your calls).

Until next issue.....Earl Sexton

1995 BOSTON ANTEC

The Color and Appearance Division held two Technical Sessions at the 1995 Antec in Boston. Both were well attended, with approximately two hundred conference being present for the majority of the first session (Session T23, “Performance of Pigmented Articles”) and somewhat fewer for the second session (Session W1, “Color and Processing Technology”). The sessions this year were not held on the same day due to scheduling difficulties. It is hoped that this “split schedule” can be avoided for future Antec meetings.

Best paper for the 1995 Antec as selected by the CAD Awards Committee was “Verification of Color Difference Equations” by Bruce Mulholland of Hoechst-Celanese. In addition, the paper “Maximization of Pearlcent Pigment in Masterbatches and Effects on Mechanical Properties” by Jim Brickley, Penn State, Erie, was selected to receive a Student Award for best paper. Both of these gentlemen will receive their awards at the 1995 Color and Appearance Retec Meeting, to be held September 24-26, 1995, at the Wild Dunes Resort, Charleston, SC.

Austin H. Reid, Jr.

SOCiETY NAMES EXECUTIVE DIRECTOR

Brookfield, Connecticut, June 15, 1995......Michael R. Cappelletti has been named Executive Director of the Society of Plastics Engineers. Mr. Cappelletti was the SPE Finance and Administrative Director since February 1984. Previously he was corporate comptroller for SKF Steel and Dual Lite companies.

Since joining SPE, Mr. Cappelletti has been part of the team that has seen the Society of Plastics Engineers grow from a $3.5-million organization to one of over $7.5 million; from 24,000 members to over 38,000 worldwide. His intent is to “keep the Society moving forward in all areas. As the international professional society of the industry, be assured that SPE will continue to offer more value to all members. The recent progress in the Leadership 2000 Strategic Plan is just the tip of the iceberg. This is a Society on the move.”

Mr. Cappelletti had served as interim Executive Director for the past 11 months. During this time, the Executive Search Committee conducted extensive interviews with candidates from around the country.

Mr. Cappelletti and his wife, Julie, reside in Waterbury, Connecticut; they have two children and one granddaughter.

1995 MEMBERSHIP DIRECTORY

NOW AVAILABLE

Now is the time to order your own copy of the 1995 SPE Membership Directory. Over 650 pages of information from more than 38,000 members, including their title, company affiliation, address, phone and fax numbers, will be of interest to all SPE members. Members are listed alphabetically, by Section and Technical Division, and for the first time, phone numbers are also included in the Section list. The Directory is only $33.95, plus $3.95 S&H ($10.00 outside North America).

The Directory can be obtained from Society of Plastics Engineers, Book Sales Department, 14 Fairfield Drive, Brookfield, CT 06804-0403 U.S.A.
The DCC presents GLOBALIZATION OF AUTOMOTIVE COLOR, a symposium on worldwide color perspective, September 11, 1995 at the Michigan State Management Center in Troy, Michigan. Three speakers will discuss common technology, regulations, consumer preferences and color trends for exterior and interior color harmony and trim materials. Speakers are George Patrick, Ciba-Geigy; Marilyn White, PPG; and Liza Lamb, Collins & Aikman. They will be joined in a panel discussion of broader global issues. Panelists are: Margaret Hackstedde, Chrysler; Jim Hothem, CALTY (Toyota); Harvey Hug, General Motors; and Janine Schwier, Ford.

DCC members and officers taught the 7th annual course in Color Technology at Eastern Michigan University May 1-5. This was the first time that the course had been held on a one week, all-day basis. Hands-on laboratory projects shared equal time with lectures, culminating in class presentations on project findings the final day. The course can be taken for two credits or non-credit and will be held again at the same time in 1996. Instructors were Pat Oldenkamp, Ken Maes, Bob Santine, Dan Sullivan, special lecturer Ralph Stanziola and adjunct professor Bill Longley.

Work is complete on DCC Bulletin No. 3, “Procedure for Visual Evaluation of Interior and Exterior Automotive Trim”, by the DCC Artificial Lighting Task Group. This is a uniform procedure agreed among General Motors, Ford and Chrysler. A DCC symposium on this work was held in March, 1995. For a copy of the procedure or information on the September 11 symposium, call secretary Dan MacDonald at (216) 656-1600.

Following the DCC/ISCC Auto DesignTech in Detroit, symposium speaker Roy Berns of Rochester Institute of Technology issued a call for support of research on industrial color difference evaluation. A panel at the symposium had discussed merits of the CMC color difference formula relative to a newer approach, simply termed TC 1-29, under evaluation by the international CIE. The DCC responded by committing $7500 annually for two years as a member of the consortium for this research.

DCC officers for 1995: president - Laura Schaefer, Morton International; vice president - Bob Santine, X-Rite, Inc; secretary Dan MacDonald, Penn Color; treasurer - Kathy Webb, BASF; past president - Pat Oldenkamp, Eagle-Ottawa Leather.

Ford has transformed Color & Trim operations into a global organization. The Dearborn group will take over functions previously performed in Dunton, England. Mimi Vandermolen is global director. Bill Longley heads global mastering (color matching standards) and Lisa Labao has global plastics color responsibility. New to the group is Ray Berch who transferred from Ford Saline.

SPE COUNCIL REPORT

Two Council Meetings have been held since the last CAD Newsletter and quite a few things have happened. The most newsworthy event is that Mike Capelletti has accepted the position of Executive Director of the Society of Plastics Engineers in July. Mike has been serving as Interim Director following the retirement of Bob Forger and the resignation of Gene DeMichello.

Those of us who know Mike are very happy to see this promotion and would like to wish him good luck.

The first Council Meeting of the year took place on February 24 and 25th in San Antonio, Texas. Elections of the Executive Committee are as listed below:

David Harper - President 1995-6, Bayer
Jay Gardiner - President-elect, Gardiner Plastics
Norman Fowler - 1st-Vice President, Xerox Corp.
Norman Behn - 2nd Vice-President, EPSCO
William Humphrey - Treasurer, R.C.Molding, Inc.
James Bracken - Secretary, Exxon Chemical

TECHNICAL TIP

Most software for color formulations include a “metamerism index” to evaluate the relative metamerism which would result from a match made with a certain pigment blend. The CIE has never defined such an index so software producers may have different approaches.

Most, however, seem to be based on computing color differences between non-spectral matches. Such computations have been shown to have less correlation to visual evaluation than for computations of spectrally similar objects.

It's best, then, to take the index with a grain of salt. If two formulations, for example, compute an index of metamerism of 0.5 and 2.1 for D65 and a second source, the 0.5 match is very likely to be the least metamerically visually. But if two suggested formulations compute to 0.5 and 0.7, don't feel so sure that the 0.5 match will be visually better.

It was also announced that the dues increase was officially passed by the necessary two thirds of the Council and that a number of budget items were restored to the 1995 Budget.

The second and third Council Meetings of the year took place at the Boston ANTEC and after the traditional installation of the new Executive Committee, the following major topics were discussed:

- Council approved a $50,000 expenditure from the Capital Fund to implement the certification process and a trial test for certification was given to 100 people. Council also had to approve the creation of a new non-profit corporation to comply with IRS rules for certification programs.

- A bylaw change was approved that allows a member in good standing to use the Society Logo on business cards only as well as membership grade in correspondence but not the logo. The bylaw (B4-b) should be read carefully before using since it is very specific.

John Copp
Council Representative
1995 SPE RETEC
COLORING PLASTICS FOR PERFORMANCE
“DEDICATED TO THE MEMORY OF JOHN (JACK) R. GRAFF, JR.”
Sponsored by
THE CAROLINAS SECTION AND THE COLOR & APPEARANCE DIVISION

Revised Technical Program Schedule

Saturday, September 23, 1995
04:00 - 6:00 P.M. Registration

Sunday, September 24, 1995
10:00 - 6:00 P.M. Registration
06:30 - 7:30 P.M. Wine & Cheese Reception

Monday, September 25, 1995
08:00 - 05:00 P.M. Registration
08:30 - 09:00 A.M. “Toxic Use Reduction Approach to Formulation”, Robert Swain, Chroma
09:00 - 09:30 A.M. “Improved Performance of Enhanced Ultramarines in Colour Concentrate Production”, Dr. Christian Duhayon, Holliday Pigments
09:30 - 10:00 A.M. “The Influence of Resin & Additives on Properties of 80% TiO₂/LDPE Master Batch”, Steve Leung/Joe Musiano, DuPont
10:45 - 11:15 A.M. “Dispersive and Distributive Mixing for Carbon Blacks in Polymers”, M. C. Yu, Cabot Corporation
11:15 - 11:45 A.M. “A Unique, Highly Transparent, Yellow Pigment for Polyolefin Fibers” Roger Reinicker, Ciba-Geigy
12:00 - 01:15 P.M. LUNCH & AWARDS
12:45 P.M. AWARDS PRESENTATION
01:45 - 02:15 P.M. “Heavy Metal Free Color Concentrates for Engineering Resins”, Harshish S. Jani, Plastics Color-Chip
02:15 - 02:45 P.M. “A Journey Through FDA Requirements for Polymer Colorants”, Donna Jackson, Eastman Chemical Company
02:45 - 03:15 P.M. “Advances in Equipment Design for Color Compounding”, David Kapper, Kobelco Stewart Bolling
03:30 - 04:00 P.M. “Improving Colour Control in Automotive PVC”, Don Nickell Canadian General
04:00 - 04:30 P.M. “A Complete Solution for Computer Color Formulation”, David Mowery, MacBeth
04:30 - 05:00 P.M. “Dyes for Performance Applications”, Wolfgang Kernath, Bayer

Tuesday, September 26, 1995
07:00 - 11:30 A.M. Registration Continues
08:00 - 08:30 A.M. “Rapid Evaluation of Pigment Color”, Dr. Frederick Simon, FTS, Inc.
08:30 - 09:00 A.M. “Effect of Optical Brighteners on Polymer Color Properties”, David Olsen, Eastman Chemical Company
09:00 - 09:30 A.M. “Efficiently Blending Colorants/Additives”, Gary R. Hovis, Conair
09:30 - 10:00 A.M. “Colorant Selection Criteria for New Product Development”, Bruce Greer, Harwick Chemical
10:15 - 10:45 A.M. “In Search of the Perfect Color, Denise Holl, Ampacet Corp.
10:45 - 11:15 A.M. “Fluorescent Colorants for Special Plastics Applications” Dr. Romesh Kumar, Hoechst Celanese
11:15 - 11:45 A.M. “Embracing the Challenge of the Future; Discussion of Techniques to Optimize Quality”, Eric Gubler, Ciba Geigy
12:00 - 01:15 P.M. LUNCH & AWARDS
12:45 P.M. GUEST SPEAKER
01:15 - 01:45 P.M. “Development of Cerium Red Pigment: An Alternative to Heavy Metals”, Joseph Golowski, Rhone-Poulenc
01:45 - 02:15 P.M. “TiO₂ in High Temperature Film Applications — How to Control the Lacing Mechanism”, Holly Hanson, SCM
02:15 - 02:45 P.M. “New Ultramarine Pigments Line”, Jose Mas, Nubiola SA
02:45 - 03:15 P.M. “Weathering of Black, Thin-Gauge Polyethylene Films”, Dr. Prakash Patel/Dr. Rodney Taylor, Ampacet/Columbian Chemical
03:30 - 04:00 P.M. “Hindered Amines Effects on Dispersion”, Steven Goldstein, BASF
TERRA TECH NEWS

The Terra Community College "Coloring of Plastics" Advisory Board met on June 18, 1995 at the College in Fremont, Ohio, and Dennis Meade was elected as Advisory Board Chairman. New members to the Board are Joe Cameron, GE Plastics, and Larry Campbell, Americhem.

Curriculum issues were discussed with particular focus on course syllabus and associated matters. These items are currently under revision since the College gained Community Status.

The new Engineering Building at Terra is underway. Classes should be in session in the new building for the 1996 Winter Quarter starting after the New Year Holidays. The new space for Plastics will be about twice the existing space now being used.

SPE/CAD Advisory Committee* working lunch with Terra Community College Plastics Color Curricula Committee: Left to Right - Larry Campbell* [Americhem], Chuck Swearingen, Jamie Przybylski, Gordon Saam, Jim Laremore, Bob Charvat* (partially hidden), George Rangos* [Cerdec], Dennis Meade* [Phoenix Color]. Photo by Joe Cameron* [GEPlastics]. Bruce Muller* [Teknor Apex] not present is also on the Committee.

Front to Back - Bob Charvat [Terra], Dennis Meade [Phoenix Color], Chuck Swaringen [Terra], George Rangos [Cerdec], Larry Campbell [Americhem], Gordon Saam [Terra] line up to greet students at the entrance of the soon-to-be completed $7.4MM expansion of Terra Community College which will house the Plastics Color Laboratory. Photo by Joe Cameron [GEPlastics].
Red Haslinger, Construction Superintendent leads SPE/CAD advisors through the plastics processing area of the new laboratory. Light to Right - B. Charvat (back), G. Rangos, D. Meade (back), R. Haslinger, J. Laremore, J. Przybylski, L. Campbell. Photo by J. Cameron.

View of the addition from the interior campus of Terra Community College.
INTRODUCTION

The acceptance of polymers in every aspect of our daily lives is in no small part a result of the development of highly efficient pigments and stabilization systems. Stabilizers, unlike many other additives, are inherently "reactive", i.e., they work by reacting with the pro-degradants in polymeric systems.

Of course, this inherent reactivity is desirable and designed into the stabilizers' chemical structure. The trade-offs between the desired reaction with pro-degradants and the potential for undesirable reaction (or interaction) with other components in a polymer system poses challenges to plastic compounders. In the following discussions we examine several factors influencing interactions between Hindered Amine Stabilizers (HAS) and Pigments including: concentrations; processing; and HAS structure.

EFFECT OF HAS ON COLOR STRENGTH

It has previously been reported that Hindered Amine Stabilizers can have a detrimental effect on pigment color strength. We confirm these earlier results and observe that these interactions may be exacerbated when HAS and pigments are present together in high concentration, e.g., when melt compounded in concentrates or masterbatches.

1. Effect of Concentration

The effect of additive and pigment concentration on color strength is easily demonstrated by comparing the color strength of Pigment Blue 15:1 pigmented polypropylene plaques without HAS to: 1) a plaque prepared from HAS-1/Pigment concentrate; and 2) a plaque prepared by adding HAS-1 and Pigment directly to the polypropylene at the final letdown concentration. All concentrates and letdowns were prepared in a laboratory internal mixer. Delta E values, relative to a control sample containing no HAS, are reported in Table 1 for these various addition techniques. (Although Delta E values only indicate a change in color, the observed effect is always a strength loss.) As can be seen, only when the HAS and Pigment are first allowed to be in contact in high concentrations is a significant loss of color-strength evident. If the pigment and HAS are not first in intimate contact, very little color shift is seen. Further evidence of the effect of concentration and the need for close contact of the HAS and pigment is observed when a plaque is prepared from separate concentrates of pigment and HAS, i.e., a "salt and pepper" approach. In this case, good color strength is achieved (Table 1).
Table 1. HAS / Pigment Concentration Effects on Color Strength

<table>
<thead>
<tr>
<th>Pigment / HAS Addition Method</th>
<th>Delta E of Plaque vs. No HAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigment Blue 15:1 concentrate + No HAS-1</td>
<td>0 (control)</td>
</tr>
<tr>
<td>Pigment Blue 15:1 and HAS-1 In concentrate</td>
<td>12</td>
</tr>
<tr>
<td>Pigment Blue 15:1 and HAS-1 Added to PP at Final Concentration</td>
<td>2</td>
</tr>
<tr>
<td>Pigment Blue 15:1 and HAS-1 Added in Separate Concentrates</td>
<td>3</td>
</tr>
<tr>
<td>a) All Plaques contain 0.25% HAS-1 and 0.30% Pigment in Profax 6301</td>
<td></td>
</tr>
<tr>
<td>b) Concentrate containing 12.5% HAS-1 and 15% Pigment</td>
<td></td>
</tr>
</tbody>
</table>

These effects are not unique to a single pigment class as is seen when comparing plaques prepared from HAS/ Pigment concentrates using various pigments (Table 2).

Table 2. Effect of Pigment Variations

<table>
<thead>
<tr>
<th>Pigment with HAS-1</th>
<th>Delta E of Plaque vs. No HAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigment Yellow 95</td>
<td>16</td>
</tr>
<tr>
<td>Pigment Yellow 93</td>
<td>14</td>
</tr>
<tr>
<td>Pigment Blue 15:1</td>
<td>12</td>
</tr>
<tr>
<td>Pigment Blue 15:3</td>
<td>12</td>
</tr>
<tr>
<td>Pigment Black 7</td>
<td>10</td>
</tr>
</tbody>
</table>

a) All Plaques contain 0.25% HAS-1 and 0.30% Pigment in Profax 6301 prepared from concentrate containing 12.5% HAS-1 and 15% Pigment.

To understand the phenomena being observed, plaques were pressed to 10 mil thickness (25.4 μm) and viewed under an optical microscope. We observe the pigment in the sample prepared from concentrate is less well dispersed, hence yielding poorer color strength. Apparently, the HAS is either hindering the pigment dispersion or causing pigment agglomeration. (No effect on polymer nucleation could be demonstrated by DSC experiments as had been reported earlier.)

2. Effect of Work

Evidence that the observed agglomeration is due to some weak attractive interactions and not a true chemical reaction is provided by the observation that the agglomeration is somewhat reversible by imparting more work into the pigmented polymer in the form of additional heat/shear. The effect on color strength of a HAS/Pigment concentrate which has undergone further processing of extrusion and fiber spinning is shown in Table 3. The concentrate used to prepare the initial plaque was let down in a 1” laboratory extruder and finally spun into fiber. The color strength is seen to improve with further processing.

Table 3. Effect of Work (Processing)

<table>
<thead>
<tr>
<th>Pigment Yellow 95/HAS-1</th>
<th>Delta E of Plaque vs. No HAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Concentrate - Internal Mixer</td>
<td>16</td>
</tr>
<tr>
<td>From Concentrate - Laboratory Extruder</td>
<td>12</td>
</tr>
<tr>
<td>Laboratory Extruder Letdown - Spun into Fiber - (fiber pressed into plaque for color measurement)</td>
<td>6</td>
</tr>
</tbody>
</table>

a) All Plaques contain 0.25% HAS-1 and 0.30% Pigment in Profax 6301 prepared from concentrate containing 12.5% HAS-1 and 15% Pigment

It should be emphasized that the extent of pigment agglomeration is obviously affected by the dispersion/processing techniques. Depending on the relative concentrations of pigment and HAS, the extrusion conditions, and other factors - the effect may be significant, slight, or nonexistent. Actual processing in production equipment may or may not yield the effect to the same degree.

Further evidence of that there is no strong interaction between the pigment and the active functionality of HAS-1 is demonstrated by measuring the light stabilizing performance of fibers spun after pigment and HAS incorporation using the concentrate, letdown, and salt and pepper techniques. One might have predicted if the HAS is effecting the pigment color strength, the pigment may effect the HAS efficacy. However, no significant difference in light stability after exposure in an xenon-arc-weatherometer is observed as a result of HAS/pigment addition technique (Table 4).
Table 4. Effect of Pigment Dispersion on Light Stability of Fiber

<table>
<thead>
<tr>
<th>Pigment / HAS Addition Method</th>
<th>Delta E of Fiber (before exposure) vs. No HAS</th>
<th>SAE J1865 Catastrophic Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigment Yellow 95 Concentrate + No HAS-1</td>
<td>0 (control)</td>
<td>540 kJ</td>
</tr>
<tr>
<td>Pigment Yellow 95 and HAS-1 in concentrate</td>
<td>8</td>
<td>4400 kJ</td>
</tr>
<tr>
<td>Pigment Yellow 95 and HAS-1 Added to PP at Final Concentration</td>
<td>2</td>
<td>4500 kJ</td>
</tr>
<tr>
<td>Pigment Yellow 95 and HAS-1 Added in Separate Concentrates</td>
<td>1</td>
<td>4400 kJ</td>
</tr>
</tbody>
</table>

a) All Samples contain 0.25% HAS-1 and 0.30% Pigment in Profax 6301 prepared from concentrate containing 12.5% HAS-1 and 15% Pigment.
b) Fiber exposed as knitted sock in Xenon-Arc Weatherometer until catastrophic failure by scratch test.

3. Effect of HAS Structure on Color Strength

The efficacy of HAS as stabilizers is attributed to a cyclic stabilization mechanism regenerating the HAS^3 (Figure 1).

Figure 1. Regenerative Mechanism for HAS

Activation of the HAS is generally accepted to involve oxidation to the nitroxy, >NO^+ . The most common HAS structure is the secondary amine (>NH), though the tertiary >N-C=H HAS is also can be oxidized to the nitroxy as readily as the >NH HAS^3 and is a very active stabilizer.

HAS-2 was the first commercial HAS used as a light stabilizer. Limitations related to the low molecular weight (e.g., volatility and migration rates) resulted in the development and commercial acceptance of the high molecular weight HAS-1. (See Figure 2 for HAS structures) While HAS-1 is an extremely good light stabilizer, it also has potential limitations related to the color strength problems describe above.

HAS Basicity

Hindered Amine Stabilizers are inherently basic in nature, due to the amine functionality, and have the potential for reacting with other ingredients in a polymer. The HAS stabilization mechanism requires that the HAS functionality is present as an amine and is not converted to an acid by reaction with acidic species in the polymer. Examples of applications where acid compounds can have a detrimental effect on HAS efficacy are acid cured coatings, flame retardants applications, and PVC.

One often reported measure of the tendency of a HAS to react with acids is the acid dissociation constant or pK_a:

\[
\text{Amine-H}^+ = \text{Amine} + H^+ \quad K_a = [H^+][\text{Amine}]/[\text{Amine-H}^+] \\
pK_a = -\log K_a = pH - \log[\text{Amine}]/[\text{Amine-H}^+] 
\]

The pK_a for the tetramethyl piperidine functionality (active functionality in HAS) is approximately 9, indicating a basic system relative to water.

Wide acceptance of alkoxy amines "NOR" HAS in the coatings industry is a result of the relatively low pK_a ~4 and hence good performance in acidic systems. These NOR HAS are also observed to show little color strength problems with pigment interaction as is shown in Table 5.

Measured pK_a for an >N-CH=H HAS are comparable to the >NH analog, e.g., ~9. A good correlation is suggested between the pK_a for the various HAS structures and color strength, with the notable exception of the tertiary amine HAS-3. HAS-3 has a high pK_a, yet, surprisingly, does not show pigment interactions similar to those seen with the >NH HAS as one might have predicted. It is possible that the interaction between pigments and HAS are related to basicity, but the pK_a measurement is not a good measurement of HAS basicity in a polymeric system.
Table 5. Effect of HAS Structure on pKa and Color Strength

<table>
<thead>
<tr>
<th>HAS in Concentrate with Pigment Blue 15:1</th>
<th>Delta E of Plaque vs. No HAS</th>
<th>pKa Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAS-1: &gt;NH</td>
<td>12</td>
<td>9.2</td>
</tr>
<tr>
<td>HAS-3: &gt;NCH₃</td>
<td>1</td>
<td>9.1</td>
</tr>
<tr>
<td>HAS-4: &gt;NCH₂CH₂OCOR</td>
<td>1</td>
<td>6.5</td>
</tr>
<tr>
<td>HAS-5: &gt;NH</td>
<td>15</td>
<td>9.6</td>
</tr>
<tr>
<td>HAS-6: &gt;NOR</td>
<td>2</td>
<td>4.1</td>
</tr>
</tbody>
</table>

a) All Samples contain 0.25% HAS-1 and 0.30% Pigment in Profax 6301 prepared from concentrate containing 12.5% HAS-1 and 15% Pigment.
b) pKa by non-aqueous titration

Explanations for the unpredicted performance of HAS-3 based on apparent basicity may be related to the appropriateness of pKa values in non-aqueous systems. While pKa values are good predictors for reaction with small proton (H⁺) as the reference acid, these values do not account for steric effects that may be observed when reactions involve larger acids. Further, pKa is a measure of relative dissociation of acids in water and may not be relevant to non-aqueous non-polar polyolefins. Acidity and basicity are known to have a strong dependence on the polarity of the solvent. Other factors may come into effect in understanding the chemistry behind the observed difference in interactions between pigments and secondary >NH HAS-1 or HAS-3, or the tertiary >NCH₃ HAS-3.

CONCLUSIONS

Loss of color strength due to interactions of HAS and pigments is due to agglomeration of the pigments when present in high concentrations with the HAS. The extent of agglomeration can be effected by the addition methods and the processing conditions. Where poor color strength is observed, it may require the addition of additional pigment for color matching. Additional pigment added to compensate for strength loss may effect other properties of the system, for example lightfastness and transparency.

HAS-3, a high molecular weight tertiary HAS useful in high surface area applications, has been demonstrated not to show the tendency to cause...
pigment agglomeration similar to that seen with the traditional secondary HAS. While all HAS provide excellent light stability in pigmented systems, HAS-3 is preferred in many color critical applications.

EXPERIMENTAL

Color Measurements: ACS Cromasensor CS-5 Spectrophotometer; D65 illuminant, 10° observer.

Internal Mixer: Haake Buchler RHEOCORD 40; Mixing bowl with CAM Blades

Extrusion: MPM Superior Extruder; 1" general purpose screw, 24:1 L/D

Fiber Extrusion: Hills Research Fiber Extruder Model REM-3P-24; 10 dpf

Accelerated Weathering: Atlas Ci85 Xenon Arc Weatherometer

ACKNOWLEDGMENTS

This work is a consequence of the combined efforts of Ciba Additives and Ciba Pigments Division’s joint working group - FIGS (Fiber Investigative Group).

The authors would like to acknowledge P. Therrien and R. Bass for their excellent work in generating the data in this paper; and to thank the management of Ciba Geigy Corp., USA and Ciba Geigy Ltd. for permission to publish this paper.

REFERENCES

1. Due to the increasing acceptance of Hindered Amine Light Stabilizers as thermal stabilizers, they are referred to as HAS in this paper, not the traditional HALS. See for example: P. Gijsman; Polymer Degradation and Stability; 43(1994); p171.


3. E.T. Denisov; Polymer Degradation and Stability; 25(1989); p209.

4. D. R. Bauer; Polymer Degradation and Stability; 28(1990); p115.


6. Gold; Prog. Stereochem. ; 3(1962); p169

ANTEC ’96 “PLASTICS - RACING INTO THE FUTURE”

The 54th ANTEC will be held in Indianapolis, Indiana on May 5-9, 1996. This is the largest worldwide conference for plastic professionals to gather and present technical papers. If you have an interesting project you are working on or have a topic which you believe will interest CAD members, please share your experience with us.

This conference also gives you a chance to network with fellow colleagues and promote business opportunities. Most importantly you will be a published writer.

If you intend to present a paper, you need to fill out a form which can be obtained by calling Michelle O’Donnell, SPE (203) 775-0471 or Karen B. Cohn (301) 570-5340.

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