Masterbatches

Clariant

Exactly your chemistry.

Fundamentals of Color
Utilization of Color & Additive Concentrates

Color Sells

Color differentiates one product from another. Color sends a clear message about the expected or intended use of a product. Research studies have long proven that a product's color and appearance are key factors in a consumer's purchasing decision. Unquestionably, color has become, and will continue to be, a critical element in the successful marketing of a product.

Over the years, color and plastics have forged a vitally important partnership. Technological advances in this area have given today's processors an endless range of color choices and forms. Functional additives can also be incorporated into a plastic product, improving the appearance, quality, performance, and value of the end product.

Clariant ColorWorks centers offer specialized services to help customers achieve the aesthetics, functionality and manufacturing efficiencies that provide a competitive edge. These worldwide facilities offer comprehensive support to customers as they evaluate possible colorant and additive packages, part shapes, quality standards and base resin materials. With total project roll-out and color management support, ColorWorks products go from concept to launch more smoothly, in less time, at optimal cost.

Following are brief descriptions of types of colorants and common coloring methods:

1. Masterbatches

Of all the choices available to processors today for coloring polymers, masterbatches or color concentrates are overwhelmingly preferred. Masterbatches are highly concentrated pelletized colorants and/or additives dispersed in a polymer vehicle. They offer processors numerous benefits, including the following:

- Competitive operating costs
- Maximum equipment utilization
- Optimal process flexibility
- Reduced inventory costs
- Decreased lead times
- Superior lot-to-lot consistency

This is the core business of Clariant Masterbatches; however, in some cases, we do supply other types of colorants:

2. Pre-Color or Compound

This product is custom-matched and colored by either a resin producer or a custom compounder. The molder or extruder need not blend, disperse or distribute the color. Quality is usually high, yet the product can be expensive and subject to long lead times; therefore it is usually not a viable option for small quantities or special effects.

3. Dry Color

An in-house process using powdered, pre-matched colorant mixtures, it is the least expensive coloring method. Dry color is messy to work with, and environmental implications must be kept in mind. The use of dry color in the NAFTA region has almost ceased in all markets except some PVC applications. Clariant Masterbatches North America can produce dry color in limited quantities.

4. Multipurpose Concentrates

Based on a multipurpose carrier system, these color concentrates are suitable for use with a wide range of polymers and are generally available in small quantities from stock. They can be cost-effective where low levels of colorant are required. Clariant offers multipurpose concentrates through distributors and direct sales.

5. Liquid Color

A cost-effective method where low levels of colorants are required, liquid color is good for delivering heat-sensitive additives into polymers. A special pump is required to disperse the product. Liquid color has a relatively short shelf life, and disposal can be both difficult and expensive. There are several advantages of using liquid color, depending on the application and polymer being colored:

- It can be used as a multipurpose coloring system in some applications.
- Facilitation is fast, with easy color changeovers.
- It can be used to eliminate the need for a release agent.

Clariant Masterbatches produces custom-designed liquid color vehicles for selected applications.

6. Single Pigment Concentrates (SPCs)

SPCs contain only one pigment or one additive or one pigment and additive combination, plus polymer in a pellet form. SPCs may also be blended to produce a custom color. They are very highly loaded and fully dispersed. With an average let-down ratio of 1%, they offer a processor the following advantages:

- Maximum color strength
- Critical dispersion
- Lower coloring costs
- Improved lot-to-lot consistency
- Better reproducibility from lab trial to production

Clariant Masterbatches produces SPCs based in polyethylene, polypropylene, polyamide, polystyrene, and polyester.

Masterbatches: The Basics

Color concentrates are produced largely, but not exclusively, with pigments, dyes, and SPCs. Pigments are highly colored bodies available as very small particles – infinitesimally divided particles. In coloring thermoplastics, pigments are dispersed in the plastic medium. Each tiny particle of pigment is totally separated from every other particle of pigment. Each is surrounded by plastic – encapsulated within plastic.

If you could look at a brilliantly colored plastic object under high magnification, you would see that the color is not continuous, but made up of many tiny dots of color, each dot representing a particle of pigment. Normally, the eye sees the aggregate color. The problem in utilizing pigments is that the particles have a tendency to clump together to create specks, or agglomerates.

Unfortunately, although a speck can be made up of hundreds of individual particles, it contributes no more to the final color than does one of the ultimate particles. If the speck gets big enough to be seen with the naked eye, it could result in a rejected piece. To use pigments efficiently, to get maximum "value," perfect dispersion is a must.

The separation of particles in a plastic medium is called "dispersion." The achievement of perfect dispersion is the beauty of the color on the one hand and economy on the other. The better dispersed a pigment is, the less will be needed to color a given job.

Most colors are matched from more than one pigment. For example, a medium green color can be created using white, green, and yellow pigments. Every particle of each individual pigment must be perfectly dispersed. If one pigment is developed more efficiently than another, the color will not be correct.

Perfect dispersion is especially essential for masterbatches due to the high colorant loading of this coloring method. This is because – in use – the concentrate is going to be diluted many times, under varying conditions. Pigment dispersion must be perfect, so that despite the dilution the colors remain true, and the pigments do not agglomerate.

Q. ***What makes such a compound a masterbatch? How does a masterbatch differ from an ordinary colored compound?***

A. The pigment level is vastly increased, possibly 20 to 200 times. This multiple is a color concentrate.

It is a reservoir of perfectly dispersed color matched colorants. It has multiple coloring power. It readily gives up its coloring power to color a much larger quantity of plastic material.

The requisite amount of natural material is mixed with the concentrate. This is put through a screw-based machine, and the product is uniformly colored and perfectly color matched.

This allows the fabricator to become its own compounder and to color products without the responsibilities of running an in-house color lab.

In addition to pigments and dyes, masterbatches can be filled with glass, talc, rubber, stabilizers, slip agents, foaming agents, flame retardants, antistats, etc.

Yet the principle remains the same. The concentrate manufacturer disperses, i.e., wets out and compounds, the desired component in vast excess. The molder or extruder acquires a reservoir of the particular materials needed. The possibilities are endless.

Key Terms

Additive Concentrates
Provides performance-enhancing properties derived from sources such as antistatic agents, ultraviolet inhibitors, antioxidants, slip agents, foaming agents, laser marking agents, and fragrances, dispersed into a carrier resin of choice and ready to introduce to your mixture of color and matrix polymer.

CESA®
Clariant's line of standard and specialty additive masterbatches, providing a vast array of performance-enhancing features (e.g., flame retardants, antiblock/slip agents, light stabilizers).

Color Concentrates
Synonym for masterbatches.
Used interchangeably, worldwide.

ColorWorks®
Clariant's seven centers, located around the globe, offering specialized services for product designers, engineers and brand managers. Services range from color consultation, color matching and 3D prototypes to on-site molding, extrusion and compounding, including an extensive variety of analysis and testing methods. Total project roll-out and color management support enable products to go from concept to launch more smoothly, in less time, at optimal cost.

Custom Concentrates
Custom color designed specifically for your company and for a specific application.

Dry Color
A formulated mixture of raw ingredients, not dispersed into any vehicle or carrier.

ENIGMA™
Clariant's state-of-the-art line of special-effect masterbatches used in packaging, sporting goods, appliances, automotive, and more.

Hue
The actual color desired.

HYDROCEROL®
Clariant's extensive family of chemical foaming and nucleating agents, helping optimize product performance and aesthetics across a broad range of industries.

Let-Down Ratio
A term that defines the strength or coloring power of a concentrate. It indicates the number of pounds of an uncolored polymer that can be colored by one pound of concentrate. A common let-down ratio is 50:1. This means that one pound of this concentrate has enough power to color 50 pounds of uncolored polymer. Many people in the industry will also refer to this as a percentage (e.g., 50:1 = approx. 2% color, 25:1 = approx. 4% color, 100:1 = approx. 1% color). Occasionally, an application will be best matched with a "1.5%" LDR, for example. The percentage terminology is easier to use in such a case.

Liquid Color
A product that is actually a form of concentrate with functional or cosmetic ingredients dispersed in a liquid vehicle. Its appearance, in its container, is similar to that of a paint. It is usually pumped into the feed throat of an extruder or injection molder.

Masterbatches / Concentrates
Plastic compounds that include a high concentration of a pigments and additives. They are mixed in appropriate quantities with a base plastic material to produce a plastic component or finished product. For example, color masterbatches are extensively used in a variety of plastics applications, as they provide a clean, convenient, and economical method of obtaining accurate color shades.

Multifunction Masterbatches
Clariant's line of combined color and additive masterbatches (e.g., UV green or white w/antistat).

Multipurpose Concentrates
Masterbatches that can be used interchangeably in multiple polymers, providing increased inventory flexibility.

OMNICOLOR®
Clariant's multipurpose color concentrates for a full spectrum of commodity and engineering resins, available in over 100 standard colors and in small lots.

Opacity
This property is an evaluation of the hiding power of the final product. To what extent does it limit the transmission of light? Opacity is a very important property in matching colors. Certain thermoplastics, such as ABS resins, are quite opaque in their uncolored state. The pigment loading must be high enough to override the basic opacity of the matrix material. If the colorant loading is not high enough, there will be shading in the product due to the strength of the original color of the matrix material. Some thermoplastics incur a color shift during a heat cycle. The concentrate must introduce enough colorant to completely hide this shift.

Polymer Matrix / Carrier Resin
The diluting medium. The concentrate is "let down" in a specific polymer type.

REMAFIN®
Clariant's family of masterbatches for olefins, offering superior color dispersion at extremely low usage levels. Available in custom colors and small lots.

RENOL®
Clariant's line of masterbatches affording exceptional processability and brilliant color for virtually all non-olefin-based polymers.

Utilizing Masterbatches

Regardless of the process or product application, processors have one thing in common: an extruder-based machine. The function of the extruder is to heat the thermoplastic using heat from two sources: 1) primary heat derived from frictional energy, and 2) partial heat derived from the barrel heaters.

When your extruder is performing efficiently, it delivers uniformly heated, perfectly plasticized material at exactly the correct viscosity and temperature. In injection molding, this means perfectly filled, stress-free parts. In extrusion, this means holding to perfect shapes. Normally, you will be making every effort to set up your machines to achieve such conditions. It is significant that such conditions are also the optimum conditions for diluting concentrates and distributing them uniformly into the polymer matrix.

Selecting a Color

Your color supplier will require the necessary information for providing a color or additive concentrate sample to you. Discussion should include the following:

- Intended polymer
- Desirable let-down ratio
- Color tolerances
- Part thickness
- Special effects desired
- Processing temperature
- Regulatory requirements including FDA, USDA, EU, REACH, CONEG, BgVV, JORF, NSF, JIS, JOSPHA and others
- And, most important, a color target or standard

Clariant color specialists have worked with a wide variety of color targets, including scraps of metal, glass, wood, and paper, as well as bath beads, threads of cloth, liquid contents (e.g., shampoo), and photographs! Achievement of an optimal color match will occur when a technician is provided with an established industry color standard, a molded chip or existing processor concentrate.

The color matcher will need to know if the color target will have matching components molded in another shop or in different polymers.

You will receive molded plaques and, if requested, a sample of the concentrate for production trial. This sample will be produced to the highest practical let-down ratio, unless you have decided to standardize on one ratio.

Because the cost of the raw materials varies, concentrates are priced individually after the color matching process.

Color Trials

Begin by weighing out the proper amount of concentrate and natural polymer and mixing them together so that the concentrate is uniformly distributed. Weigh your components as accurately as possible, or work out a volumetric method. The important factor is that once you establish a mixture, you must be able to reproduce that mixture exactly, as many times as necessary.

The next step is to mix the components, using a drum tumbler, a ribbon mixer, a paddle mixer, a double cone blender, a twin shell blender, etc. Volumetric or gravimetric machines operate on a continuous basis. They are clean, accurate, and economical. Whichever method you use, it must mix the materials uniformly and, batch by batch, the mixtures must be identical.

Once the mixture is complete, it is transported to a fabricating device (extruder, blow molder, or injection molder). No special technique is required to properly utilize concentrates, because the operating conditions that will give you the best extrusions or best molded parts will also give you the best concentrate distribution.

Considerable technical assistance is also available in this field. Your concentrate supplier should be able to suggest starting processing conditions for each material, and your set-up people can easily work out what is best for your particular application.

The color concentrate manufacturer can often put together concentrates with especially low viscosities that will distribute more readily.

Clariant is experienced with all types of color-handling options, from feeders and mixing nozzles to gravimetric blenders. We can recommend the most efficient screw design and provide complete processing reviews including machine audits.

Where Masterbatches Are Used

Concentrates can be used profitably in every thermoplastic material for nearly every end-use and can be let down in any extruder-based fabricating device. A fabricator can establish any combination of two or more concentrates and produce an exclusive line of colors.

RENOL Masterbatches Product Listing

Colors	Nylon 6 & 66 Unfilled (Non-HS)	Nylon 6 & 66 Glass Filled (Non-HS)	PC	Acetal (POM)	PBT	ABS	NBR (Barex®)	PPA (Amodel®)
White	CNY02655	CNY12057	CPC07327	CPA02656	CPBT02796	CABS07526	CNBR00212	00025197
Lt. Yellow				CPA03966				
Yellow	CNY12055	CNY12055	CPC07153	CPA03964	CPBT02800	00049305	CNBR00250	00025195
Orange	CNY12056	CNY12056	CPC07154	CPA03970	CPBT02801	00049307		00025196
Pink	CNY12054	CNY12054	CPC07155	CPA03969	CPBT02805			00025194
Red	CNY12050	CNY12050	CPC07152	CPA03971	CPBT02799	00049306		00025190
Dk. Red	CNY13996							
Purple	CNY12049	CNY12049	CPC07156	CPA03968	CPBT02806			00025189
Lt. Blue				CPA02664		00049300		
Blue	CNY12048	CNY12048	CPC07150	CPA02665	CPBT02803	00049301	CNBR00262	00025188
Dk. Blue						00049302		
Green	CNY12051		CPC07151	CPA03967	CPBT02804	00049303	CNBR00263	00025191
Dk. Green				CPA03965		00049304		
Tan	CNY12052	CNY12052	CPC07147		CPBT02797	00049309	CNBR00224	00025192
Brown	CNY12053	CNY12053	CPC07149	CPA03963	CPBT02802	00049310	CNBR00159	00025193
Lt. Gray	CNY12058	CNY12058		CPA03973		00049299		00025198
Dk. Gray	CNY12059	CNY12059	CPC07148	CPA03974	CPBT02798	00049298		00025199
Black	CNY04892	CNY04892	CPY01232	CPA02654	CPBT01338	CABS17415	CNBR00142	CPTA00001

Note: Colors are indicative. Actual colors may vary.

Process

- Injection molders
- Blow molders
- Sheet extruders
- Monofilament extruders
- Multifilament spinners (textiles)
- Compounders
- Profile extruders
- Film extruders

Application

- Business machines
- Packaging: personal care, food, and industrial
- Electronic/electrical applications
- Appliances
- Medical components
- Housewares
- Toys
- Automotive/transportation
- Wire and cable
- Textile, carpet, and upholstery fibers
- And many other applications

Material/Polymer

- ABS resins
- Acrylics
- Cellulose
- Filled materials of all types
- Nylons
- Polyacetals
- Polycarbonates
- Polyesters
- Polyethylene
- Polypropylene
- Polystyrenes
- Polyurethane
- Thermoplastic rubber
- Vinyl
- And a wide variety of other thermoplastic resins

PPA (Amodel HS)	HTN (52G Series)	HTN (51G Series)	LCP (Xydar® & Zenite®)	PPO (Noryl® GTX)	PSU (Poly-sulfone)	PESF (Polyether-sulfone)	PPSU (Polyphenyl-sulfone) Radel®	PEEK (Poly-etherether-ketone)	PEI (Poly-etherimide)
00037250	AC02620004	AC02620005	AT04620000	CNY02655	00028581	00028931	AS03620004	AK03642400	AK02620003
							00061410		
00035686	AC13620003	AC13620004	00034500	00034219	00028685		AS13620013	AK13620000	AK13620004
00045269	AC23620007	AC23620008	00034498	00036024			00041405	AK23620000	AK24620007
00029624	AC32620006	AC32620008	00035542	00036026			AS32620007		AK32620003
00035687	AC33620005	AC33620007	00034496	00036188	00028689	00028924	AS33620005	AK34642400	AK34620008
			00034495	00034218		00028990	AS34620021	AK33620000	AK34620002
00049800	AC44620005	AC44620006	00034509	CNY12049		00028993		AK43620001	AK43620002
								00070218	AK52620021
00033210	AC53620009	AC53620010	00033713	CNY00310	00024167	00029002	AS53620008	AK53642401	AK53620000
00034763			00035540		00029006	00029000	AS53620015	00070217	AK54631203
00035685	AC63620003	AC63620004	00022670	CNY12051	00028693		AS62620019	AK63642400	AK62620008
			AT63620018			00028996	00041404	00083067	
00042872	AC82620028	AC82620030		00036025	00028641	00028932	AS82620010	AK32620007	AK03631200
00042875	AC83620029	AC83620031	00035543	CNY12053	00028833		AS83620002	AK83642400	00033201
00041529	AC72620032	AC72620034	AT72620029	CNY00304	00029010	00028934	AS72620020		AK73620018
00049799	AC74620033	AC74620035		CNY00302	00028636	00028999	AS73620022		AK73620007
CPTA00001	AC94620005	AC94620004	00051991		CPSF00528	00028988	AS94620005	AK94620005	00051571

Problem Solving: Dispersion & Distribution

Dispersion refers to the operation of creating the concentrate. Remember the green concentrate that consists of a white, yellow, and green pigment, plus the matrix? The color concentrate producer must thoroughly mix these pigments with the plastic base, and each particle of color must be completely encapsulated in plastic.

If dispersion is incomplete, a defect may arise in the finished part, showing as a streak of one of the individual colorants (green, white or yellow). Defects of this nature are very difficult to correct in the processor's plant, and the concentrate should be returned to the concentrate producer for correction.

However, in all fairness, before this action is taken please determine whether the specks or streaks are, in fact, inherent in the concentrate and are not dirt specks or spots of oil. Sometimes a housekeeping problem is involved.

Distribution refers to the operation of the processor (molder or extruder) in which the concentrates and the matrix material are thoroughly mixed to form a uniform color. Any failure of the concentrate and the natural resin to melt evenly and mix completely will show up as a series of light and dark areas – usually streaks in the finished part. This is the problem most frequently encountered.

The solution frequently lies in the maximum use of the screw, and the basic principle is the achievement of early melting of the contents of the screw, thereby utilizing the maximum length of the screw for color mixing.

Step One

The first and usually most helpful step is raising the heat in the feed zone. The changes needed are not substantial, and the heat should be raised gradually in increments of 25 to 50˚F. The objective is to bring the temperature of the rear feed zone above that of the rest of the machine. Molders may object on the grounds that finished part tolerances will be affected, but that is rarely the case since the overall heat balance of the machine and the plasticity of the material are not disturbed adversely. Because only the feed zone temperature is raised, it frequently is possible to decrease the overall temperature of the machine.

Step Two

Decrease the screw return speed along as much of the cooling portion of the cycle as possible. Target screw speed should be approximately 40 to 60 rpm.

These two steps should solve the greatest portion of distribution problems.

If the situation has reached the point where incomplete distribution is just short of achievement, the use of a dispersion nozzle is apt to add the final degree of mixing needed. Be sure to also consider the following:

- The machine should have an initial inspection to make sure all areas are working properly.
- A heater may be defective.
- A thermocouple may be displaced, giving erroneous readings.

Usually, a minimum dwell time in a machine is needed for the plastic material and the concentrate to be plasticized and mixed. On occasion, the following problems may be encountered:

- The volume of the cavity is too great.
- The cycle itself is too short, and the time in the cylinder is inadequate.

In extreme cases of this sort, it may be necessary to transfer the mold to a larger machine with a greater plasticizing capacity, or to increase the cycle time.

In some cases, the concentrate producer can supply the concentrate in a smaller pellet size, thus improving the ratio of concentrate pellets to plastic pellets.

In any event, close communication between the masterbatch producer and the processor will help to eliminate potential distribution problems or recognize them in the sampling stages so that corrective action can be taken before production quantities are needed.

Additive Masterbatches

Today, an extensive range of masterbatches containing a wide variety of additives is available to the plastics processor. These additive concentrates allow precise metering, especially for active ingredients such as the following:

- Antistats
- Antioxidants
- Light stabilizers
- Slip agents
- Antimicrobials
- Chemical foaming agents
- Flame retardants

Most of these additives require only small addition levels to show a high efficacy. As a result, they need to be well dispersed in suitable carrier materials.

The same also applies for highly loaded concentrates containing flame retardant or multicomponent additive formulations. The commonality is that all additive types provide performance-enhancing features or protect the polymer from environmental impact.

1. Antistats

Antistatic agents are designed to prevent a build-up of static electricity in polymers. Polymer resistance is a very desirable property for insulating applications. It can, however, create handling and other issues for plastics processors. Static charges result in the clinging of sheet or film, sticking of stacked polystyrene cups, dust and dirt attraction, or bridging of powder. A sudden discharge can create sparks that may damage certain products (e.g., computer chips) and pose an explosion hazard.

Antistats in powder or liquid form can, in addition to quick moisture absorption, pose significant handling, metering and feeding problems. To avoid these problems, more and more plastics processors use antistat masterbatches in pellet form when extruding or molding. Highly loaded masterbatches are especially helpful to improve the incorporation into the polymer.

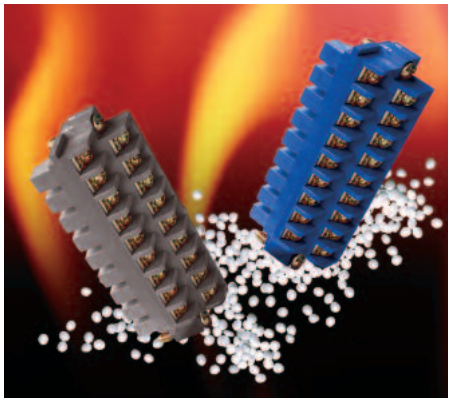
For example, if a liquid ethoxylated amine or lauryl-amide were to be incorporated into polyethylene at a 0.1 to 0.5% level, it would barely wet the surface and would be insufficiently dispersed. Specialty masterbatches with these antistatic agents and tailor-made carriers have proven to best meet the converters' processing, testing and performance criteria.

Another significant development is the availability of highly loaded concentrates in a variety of carriers that meet FDA requirements.

2. Antioxidants

Antioxidants, often called heat stabilizers, are organic compounds that inhibit or retard polymer oxidation and its degrading effects causing discoloration, change in viscosity, loss of physical properties, loss of clarity and surface crazing – or cracking.

Oxidation occurs as a result of exposure of a polymer to elevated temperatures during manufacture and long-term exposure to the environment. This process can be inhibited in several ways, and for this reason, combinations of chemically active



compounds often produce the best results. Antioxidants are usually classified as either primary or secondary, according to the nature of their chemical reaction.

Hindered phenolic or aromatic amine compounds are considered primary antioxidants, while phosphites and thioesters are considered secondary because they react later in the degradation process.

Use of antioxidants in concentrate form is highly dependent on end-use requirements. In many instances, the amount of AO present in the resin supplied by a resin producer is insufficient for long-term stability. Therefore, the addition of AO in a separate masterbatch form is necessary.

3. Light Stabilizers

Light stabilizers, also called UV stabilizers, extend the service life of polymers by inhibiting the degradation caused by various light sources.

UV stabilizers have evolved to an optimal state of effectiveness and processing ease:

TYPE ONE

Absorption of light energy and conversion to heat (e.g., carbon black).

TYPE TWO

Nickel quenchers, which extend polymer life fourfold.

TYPE THREE

Hindered amine light stabilizers (HALS) have been developed that act chemically, while scavenging radicals are formed as a result of polymer degradation.

In addition to the homogeneous distribution of these stabilizers, properly formulated UV concentrates improve the compatibility with other additives and environmental influences such as acid rain and crop protection agents.

4. Slip / Antiblock Release Agents

Most thin polymeric film surfaces have a tendency to adhere to each other as a result of accumulated static charges. They also have an undesirable tendency to adhere to metal surfaces of processing equipment. In polyethylene, materials designed to reduce this tendency are referred to as slip agents. In PVC, they are more commonly called antiblocking agents. The terms “denesting” or “release agent” are also often used, especially in PET/G and other engineering plastics.

Concentrates providing these various antiblock, slip or release functions contain different active ingredients ranging from amides, talc, and lubricants to specialty esters. Formulation and processing know-how is especially important for tailor-made applications.

5. Chemical Foaming Agents

Chemical foaming agents are compounds that decompose at elevated temperatures, forming a gas that expands plastic material to impart a cellular structure. This foam structure provides weight reduction, increased part rigidity, improved insulation and acoustical properties, as well as cost savings.

The use of CFAs offers the processor a clean, safe way of metering these agents.

In addition to structural foam molding or extrusion, chemical foaming agents are often used as a nucleant during direct gas injection with physical foaming agents such as nitrogen, carbon dioxide, freon, butane, etc. The let-downs vary from 0.1 to 0.3% in physical foams to 2% or more where no other gas is used. The loading of active ingredients varies from 20 to 70%, depending on the type of carrier resin. The primary means of selecting a chemical foaming agent is by matching its decomposition temperature to the processing temperature of the resin to be foamed.

Decomposition temperatures of CFAs can be selected by using exothermic or endothermic systems. Both types of chemical foaming agents can be altered chemical activators, such as metal oxides, lubricants and a variety of proprietary ingredients. Most applications may require some experimentation to determine the correct processing conditions and the exact use ratio of a particular concentrate.

Exothermic systems such as azodicarbonamide, liberate nitrogen, carbon monoxide, and ammonia begin to generate heat once the gas formation has started.

Contrarily, endothermic systems, which are based on carbonates/citric acid, generate carbon dioxide and water vapor. They react by consuming heat. Typically, exothermic foaming agents are used for larger parts. Endothermic systems find application in tapes, films, sheet, and reduction of sink marks in molded parts.

Additive Masterbatches (continued)

6. Flame Retardant Concentrates

More and more thermoplastics require flame retarding to meet a variety of industry specifications. Examples are molded or extruded parts for building, automotive, electrical/electronic, furniture, and textile applications.

In order to achieve good flame retardancy, thermoplastics must be highly loaded, especially to comply with the widely recognized Underwriters Laboratories (UL94 V-0*) requirements. Since high filler loading has a negative influence on the impact strength and other physical properties, the dispersion of the flame-retardant additive is of the utmost importance. This holds true for both types of flame retardants – ***halogenated and non-halogen*** active ingredients.

Typical halogen formulations contain a bromine- or chlorine-based compound and an antimony synergist. Halogen-free concentrates use phosphorous-based ingredients. Loading levels of FR concentrates can be as high as 50% by weight, with let-down ratios from 3 to 50%. Most engineering plastics require a lower loading in comparison to polyolefins or styrenics.

7. Antimicrobial Concentrates

Biocides, fungicides, mildewcides, etc., are among the chemicals that are classified as a pesticide and are therefore subject to EPA regulations. The purpose of these active ingredients is to protect plastic articles from deterioration, as well as from odors and discoloration. Small addition levels of 0.1 to 0.5 % active substance protects the articles from a large number of bacteria, yeasts, and fungi.

Antimicrobial concentrates can either be manufactured under FIFRA custom blending stipulation (40CFR 164.7) or offered as EPA registered concentrates.

8. Other Additive Concentrates

There are many other types of performance-enhancing additives, which can be incorporated into a variety of carrier resins. Examples are as follows:

- Nucleating/clarifying agents
- Optical brighteners
- Corrosion inhibitors
- Laser marking systems
- Coupling agents
- Crosslinking agents
- Impact modifiers

The manufacturer of additive concentrates has the experience and knowledge to produce tailor-made single or multicomponent masterbatches and to offer solutions to molders/extruders and end-users.

Interactions

Most extruded or molded parts are colored and contain combinations of pigments and a multitude of additives. Primary phenolic antioxidants are added to most thermoplastics to reduce long-term thermal degradation. Secondary antioxidants serve as synergists and enhance the processing stability, thus preventing molecular degradation. Phosphites are particularly effective to maintain color integrity.

The following are examples of significant combinations of pigments with UV stabilizers, antioxidants, and other additives:

- Automotive parts
- Textile fibers and monofilaments
- Stadium seats
- Crates
- Refuse/storage containers
- Housings
- Awnings
- Agricultural film
- Industrial liners
- Packaging
- Building applications

In recent years, HALS (hindered amine light stabilizers) have become the most widely used type of UV stabilizers for polyolefins, extending the life about tenfold. As opposed to UV absorbers, their functionality is independent of the plastic thickness. However, HALS are highly active radical scavengers and can cause a variety of interactions with pigments, sulfur stabilizers, and halogenated flame retardants. Migrating additives such as antistats and antislip or antiblock combinations require special formulation know-how – especially in highly loaded concentrates.

Today's end-use requirements include fast static decay times in low humidity conditions, printability, biodegradability, non-corrosiveness, food approvals, etc. Color concentrate producers must have a clear understanding of the processing conditions, the type and efficacy of these additives, and their interactions in order to provide a sound recommendation.

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