Coloring systems

Powder, liquid or granules? A method that's right for every producer

By Nick Paris and Michael Chusid

Producers have more ways to color concrete than ever before. In addition to powdered pigments and liquid colors, new granulated pigments are growing rapidly in popularity. A wide selection of color handling and dispensing systems is available, ranging from manual weighing and dosing to highly automated coloring equipment.

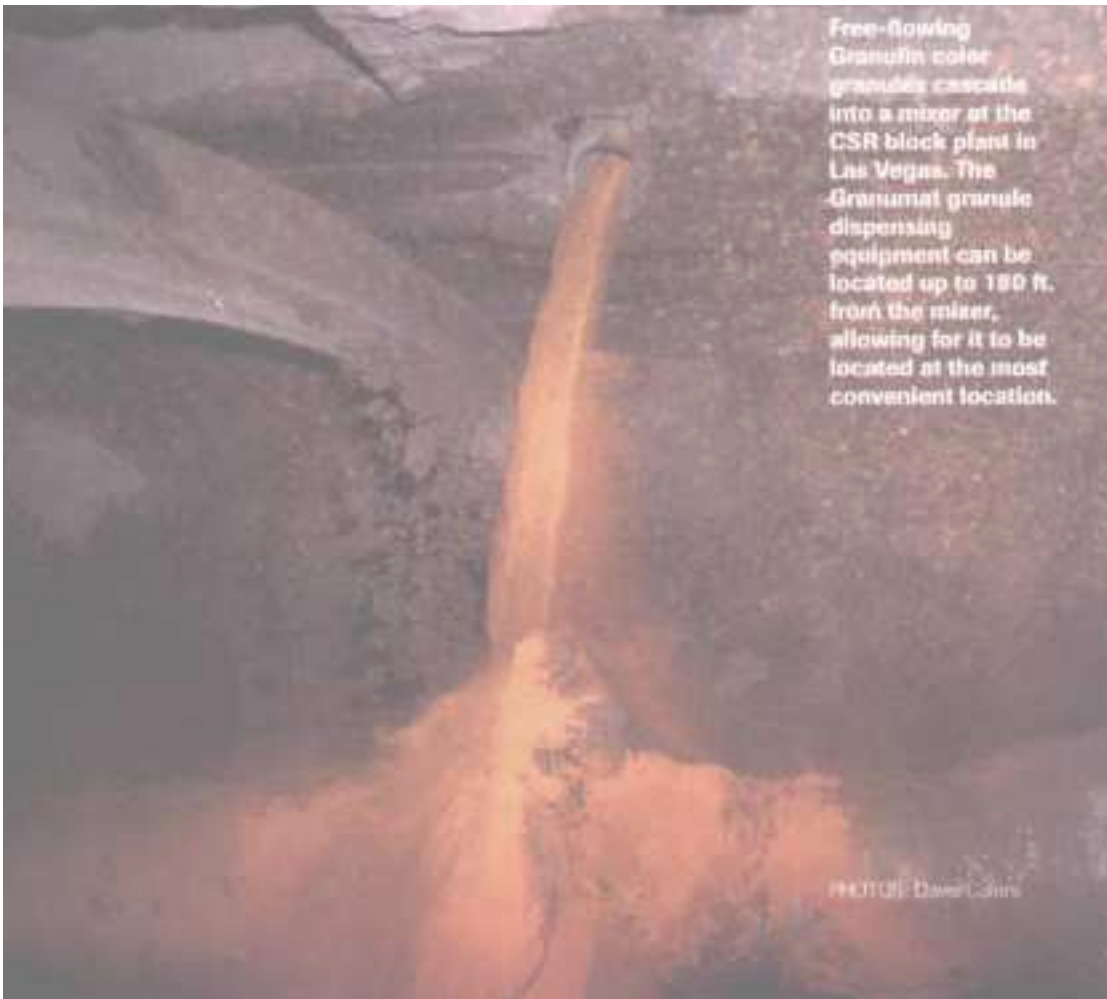
Selecting the best system for a particular concrete plant requires the producer to consider many factors, including current and anticipated demand for color; cost of pigments, dosing equipment, financing and labor; plant design and technical factors; concrete mix requirements; product line and marketing considerations; individual preferences; and management attitudes toward plant hygiene and quality control. This article provides an overview of the leading coloring products and processes available today.

Color has increased in importance to many concrete producers. For example, the availability of permanent colors has contributed significantly to consumer acceptance of concrete pavers, roof tiles and segmental retaining units. In competitive markets, many ready-mix concrete and concrete block producers report that they make more profit from value-added features like color than they do from the concrete or block itself. The increased variety of coloring options has made it easier for producers to take advantage of the growing demand for colored products by reducing costs, making it easier to retrofit existing plants, and making coloring operations cleaner, more convenient and reliable.

Granule

Liquid

Powder



Free-flowing Granulin color granules cascade into a mixer at the CSR block plant in Las Vegas. The Granumat granule dispensing equipment can be located up to 180 ft. from the mixer, allowing for it to be located at the most convenient location.

PHOTOS: Dave Collins

Manual versus automated coloring

Before picking a pigment type or handling system, a concrete producer should first consider the level of automation appropriate for a plant. While manual methods of adding pigment will always have their place, the cost of automation equipment has dropped during the past decade. Increasingly, the capital investment for automation equipment is offset by reduced manpower and inventory requirements plus other benefits, such as a cleaner plant environment and improved product quality.

Color automation systems generally include bulk storage, metering equipment to weigh and (if required) blend pigments, a means to transport pigment to a mixer, and computerized controls to operate and monitor the system. The equipment price tag can range from $20,000 or less to over $100,000 depending on the type of system, capacity, number of colors and mixers to be handled, cycle speed, flexibility, accuracy and reliability. Equipment can be bought or leased directly from manufacturers or sometimes be obtained through pigment producers as part of a purchase program.

The labor required to manually handle pigments must be looked at carefully. Some large-volume pigment users who have converted from manual systems to automation report that they have been able to eliminate a full-time production position. While most concrete "color men" are conscientious in their work, human fallibility adds to the effective cost of manual methods. Humans can make errors reading a work ticket or weighing pigments by hand. A brief distraction can lead to colors being left out of an entire batch or added so late in a mixing cycle that they may not disperse fully to produce the desired concrete color. People can make costly errors programming automatic dispensers as well. The capabilities and work practices of the plant's labor force should be considered when choosing a coloring method.

Automation frequently allows a concrete producer to reduce inventory costs. Instead of maintaining a separate stock of pigment for each concrete color, many automation systems require that only four primary colors be kept in inventory. Producers with a limited product palette may require fewer hues while others may also require a premium color or customized blends in their system.

An automation system is programmed to meter and blend just the right amount of each of the basic colors to produce the shade specified for a particular batch. While a manual operation can use just the basic colors, the time required to weigh multiple colors and the potential for mistakes generally makes it impractical. Another benefit of on-site blending is that a producer can readily reprogram a system to match a special color upon customer request. This becomes an important advantage in competitive markets, especially for architecturally specified products.

Powdered pigments

Most colored concrete, by far, is produced using pigments in their powder form. The basis for the high tint strength of powder pigments also causes their biggest drawback—dirtiness. The extremely fine, dust-like powders can be spread while opening and emptying sacks, by blow-back from the mechanical action in a concrete mixer, and by spills. Without rigorous attention to cleanliness and cleanup, powder pigments can coat a concrete producer's plant and equipment with various shades of iron oxide dust. Iron oxide is not a hazardous material, but zealous environmental health and safety officers have been known to look unkindly on any kind of nuisance dust. A clean plant makes it easier to attract and retain a top quality work force and helps to reassure a firm's customers of its commitment to quality.

Powders are packaged in a wide variety of sack sizes ranging from one pound bags to 2,000-pound "supersacks." Many pigment producers will also prepare customized "batch-sized" bags for their ready-mix customers. In the past few years, disintegrating bags have become the standard packaging for ready-mix producers. Disintegrating sacks have solved most of the ready-mix producer's concerns about cleanliness, but are not compatible with other types of concrete operations. Disintegrating bags can be tossed into a ready-mix truck without opening or pouring. The bags travel to the center of the mix where

Color is a value-added feature for concrete products. A wide range of coloring systems are available to meet the needs of all concrete producers. (Photo of Unilock Chicago, Auroara, Ill.)

Disintegrating bags with powdered pigments are increasingly popular among ready-mix producers. The pre-measured bags can be thrown into mixers without opening or pouring and are a clean and convenient way to color ready-mix concrete.

This liquid coloring system was recently installed at A-Block, a CMU producer in Needles, Calif. Liquid colors are drawn out of drums through a hose or pipe that set on top of the drums. Four pumps (center of picture) are used, one for each of the basic iron oxide colors. The cylinder in left cabinet rests on a load cell to meter the amount of liquid colors programmed into the control panel on right. Colors are then transported to the concrete mixer.

A four-color Granumat machine is used at Pavestone, Denver to color concrete pavers. Pigments in supersacks flow into a color metering system located below the production floor. There, granular pigments are weighed, blended and pneumatically transported to the concrete mixer. The very low amount of dust in granular pigments helps keep the plant clean and efficient.

the paper gets soggy and disintegrates, releasing pigments in the center of the mixer where dispersion occurs readily without producing significant amounts of dust.

Powders require the fewest steps to manufacture and are the least expensive type of pigment on a per-pound basis. Yet price-per-pound may not present the total picture. Unless one is using a disintegrating-type of bag, some waste inevitably occurs due to pigment that gets left in the bottom of the bag. Powdered pigments offer less flexibility for use with automated pigment metering systems; automated equipment designed to handle powders is generally gravity fed and must be located above the mixer. This makes it difficult to retrofit automated systems into existing concrete plants. Using pigment blends instead of the basic four colors with powder pigment dispensers makes their accuracy very acceptable. This is especially important in plants that produce small batches or lightly pigmented products where even a small variation in pigment can result in a color shift in the concrete.

Liquid colors

The primary advantage of liquid colors over dry pigments include more accurate metering with base pigments, cleaner coloring operations, and more potential flexibility in plant layout. Certain situations need to be considered before using a liquid coloring system. At some plants or during certain times, the aggregate contains all the moisture necessary for the entire mix, making liquid colors unusable. In plants where color is used infrequently, the pigments in liquid colors can settle or dry out. In cold climates, liquids can freeze in storage or shipment unless kept in heated areas.

Liquids cost more to manufacture than powders and cost more than either powders or granules to ship due to the water added to the pigments. Compared to granular pigment dispensers, a single liquid dispenser may not be able to keep up with cycle times at plants with multiple mixers or forming machines. Liquids are available in the primary hues and preblended custom colors, and are typically shipped in drums or other bulk containers.

Liquid-based pigments are produced by mixing powdered pigments in water to make an aqueous dispersion or slurry. Some color manufacturers refer to their liquid pigments as "gels" due to the products' thixiotropic or viscous consistency. Chemical dispersants and stabilizers are added to some liquid colors to help maintain the pigments in suspension without settling. Despite these additives, concrete producers must pay attention to the shelf-life of liquid colors as agitation or remixing may be required if they sit unused for a prolonged period.

A typical liquid coloring system includes pumps to extract colors from drums, a load-cell to weigh colors or a volumetric metering system, pumps and hoses to convey pigments to a mixer, and a computer to control color blending and equipment operation. Because liquid colors can be pumped over some distance, color inventory and metering can be located at the most convenient location and away from the concrete mixer. In addition, centrally controlled systems can be configured to serve several concrete mixers.

The hydraulic properties liquid colors allow for accurate metering and fast production cycles. A "slow fill" option is available with most liquid coloring systems to allow for extremely accurate metering and is especially important for measuring small quantities of pigment. At the end of each cycle, water is flushed through the system to clean it and avoid color contamination of subsequent batches and problems that might occur if pigments are allowed to dry in the lines. This water, plus the water used to manufacture the liquid colors, must be figured into the batch water required for a concrete mix.

Liquid coloring systems are most frequently used by concrete product manufacturers who consume a low to moderate volume of color or who have screw auger type continuous mixing equipment.

On-site slurry and dry-wet systems

There are two methods for manufacturing liquid colors on-site at a concrete producer's facility. In the on-site slurry system, a concrete producer manufactures liquid colors in bulk. In the "dry-wet" system, dry-pigments are blended

Liquid colors, also called slurries, are manufactured by mixing powdered pigment and dispersing agents in water using high-shear blenders.

The control panel for the Granumat automated coloring system at Unilock Chicago (background) is linked to the plant's control system.

The choice between manual and automated coloring systems depends, in part, on the concrete producer's product line. Here, red and black batches of concrete mix together in the hopper above a paver machine to produce multi-colored concrete paver units.

in water on a batch-by-batch basis. Both of these methods combine some of the features typically associated with both dry powder and liquid coloring systems. On the plus side, they both allow the use of low-cost powder pigments plus the flexibility of being able to locate coloring operations away from the concrete mixer. On the minus side, they still have most of the dusting concerns that come from handling dry pigments.

In the on-site slurry process, a concrete producer formulates liquid colors in the same way a pigment manufacturer would. Large mixing and storage tanks and a scale are required, plus all the equipment required to dispense liquid colors. The concrete producer takes full responsibility for quality control of the liquid color and requires properly trained personnel to blend colors and assure consistency from batch to batch. Despite these limitations, on-site slurry can be a viable system for concrete producers who use a large volume of color and prefer a liquid coloring system.

In the dry-wet system, powdered pigments are fed as required into a small mixing tank. The mixer is covered to limit dust problems and is equipped with a load cell to weigh the pigments as they are added. Computer controlled meters dispense the required amounts of the primary colors and water. The ingredients are then mixed, and upon a signal from the system, transported with compressed air or pumped into the concrete mixer. A water spray washes out the mixer bowl and is then forced into the concrete batch to clean the hose. Due to the time required for these operations, some dry-wet systems may not be able to cycle quickly enough to use in plants with multiple concrete mixers.

Granular colors

Granular pigments are the fastest growing type of concrete coloring. The first successful granular system was introduced in 1989 by Brockhues Corp. and is now marketed by Davis Colors. The patented method uses an automated metering system and color granules made with an organic binding ingredient which holds the pigment together during transport and then dissolves to enhance color development when mixed into concrete. The small, microbeads of pigment are free-flowing, very low in dust, and disperse readily upon being added to a concrete mix to develop full tint strength. These pigments have been successfully used in over 300 concrete plants, including block, paver and retaining wall production facilities around the world.

The organic binder used in Brockhues-type granules dissolves in water and disperses readily in any type of concrete mixer. A newer type of granular pigment uses an inorganic binder that does not dissolve in water. It depends instead upon the shearing action of the aggregate to break down the granules and may not achieve full color development with certain concrete mixes, types of mixers and batching sequences. Under optimum conditions, inorganically bound granules will develop only 80 to 90 percent of the tinting strength of an organically bound granule or good powdered pigment.

Granular pigments offer all the benefits of automation without many of the limitations of other forms of automation. The pneumatic dispensing systems offer very accurate metering and fast production cycles, can serve multiple concrete mixers, and can be located up to 180 feet from the concrete mixers. They are the most compact form of pigments available, saving about half the volume of powders. Similarly, they cannot freeze, are not limited by shelf life or settlement problems, will not dry out in hoses, and can be used in mixes which can not accept additional water.

In a typical installation, supersacks of granules are hung in a rack above a color metering system. The computer-controlled metering system weighs out the required amount of each of the primary colors and drops the blended colors into a pressure vessel. From there they are pneumatically transported to a hopper above the concrete mixer. Upon a signal from the concrete mixer, the pigments cascade into the mix and disperse throughout the concrete.

Granules offer savings when compared to liquid colors; since they contain no water, they cost less to ship and have greater tint-strength on a pound-for-pound basis. Granules are also used in manual coloring operations where they are selected over powders for their ease of use and cleanliness. They are packaged in supersacks and 50 pound bags.

Selecting the best system

As we have seen, selecting a coloring system for a concrete plant requires management to consider many factors. Before making a selection, concrete producers should visit the plants of other producers who are using the coloring systems under consideration. Pigment and equipment manufacturers are also good sources of information, especially those who offer a range of solutions and are not limited to just a single pigment type or coloring system.

To select a pigment or equipment supplier, look for a manufacturer that can provide a proven product and technical support. Equipment suppliers should be able to provide turn-key installation and rapid response when service or spare parts are required. Pigment suppliers should be willing to develop color blends or formulas to match the producer's standard product line and special color matches. Pigment availability and delivery time must also be considered along with pricing. Use a pigment manufacturer with rigorous quality control to assure uniformity from batch to batch and year to year. With the range of pigments available today, there is a coloring system available to fit every concrete producer's needs.

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Powder, liquid and granular pigments provide concrete producers with a wide range of concrete coloring systems.

Coloring Basics

Regardless of the coloring process, additives complying with ASTM C979–STANDARD SPECIFICATION FOR PIGMENTS should be used. This document establishes criteria for the alkali resistance, light resistance, water wettability, and other factors affecting the compatibility of pigments with other concrete mix components. Pigment content in concrete is limited to 10 percent of the weight of the portland cement, fly ash, and other cementitious material in the mix. Color saturation, the dosage level beyond which additional pigment has no effect on the concrete color, is nearly achieved at about six percent dosage rate depending upon the type and color of pigment used. Many popular and economical subtle shades can be produced at dosage rates as low as one percent, To assure optimum tinting strength, pigments are milled to microscopic particle size, sometimes only one-hundredth the diameter of a grain of portland cement. These fine particles mix into and bond with the cement paste which then coats the sand and coarse aggregate in the concrete.

Iron oxides are the most widely used type of pigment; they are economical, durable, pose no significant environmental or health hazard and are readily available. In addition to naturally occurring iron oxide ores, synthetic iron oxides are also used. Synthetic iron oxides provide greater tinting strength and color or uniformity. Synthetic iron oxides come in four "primary" colors: yellow, black and two different reds (yellow and blue shade reds). Chromium oxide produces green and cobalt is used for blue. Titanium dioxide can lighten a concrete color, but is seldom used because white portland cement obtains the same effect at a lower cost. The basic pigment hues are blended to produce a wide spectrum of concrete colors.

In addition to pigment, concrete color is affected by the color of cement, sand and aggregate, water-cement ratio, surface texture, curing conditions, and consistency of manufacturing and finishing operations. While integral colors are as durable as the concrete itself, the appearance of colored concrete can shift over time due to staining, erosion of cement paste from the concrete surface, or the natural yellowing of concrete as it ages. With proper quality control, modern concrete producers can reliably achieve a high degree of color consistency from batch to batch. However, it is important that end users understand that, as with any natural material, the appearance of concrete can vary whether colored or not.

While two pigment shipments may look the same to the untrained observer, differences from batch to batch, such as variations in tinting strength, can affect the color of a concrete product. Since few concrete producers have the fully equipped color laboratory necessary to measure the differences, they are well advised to consider the color manufacturer's reputation and quality control program.

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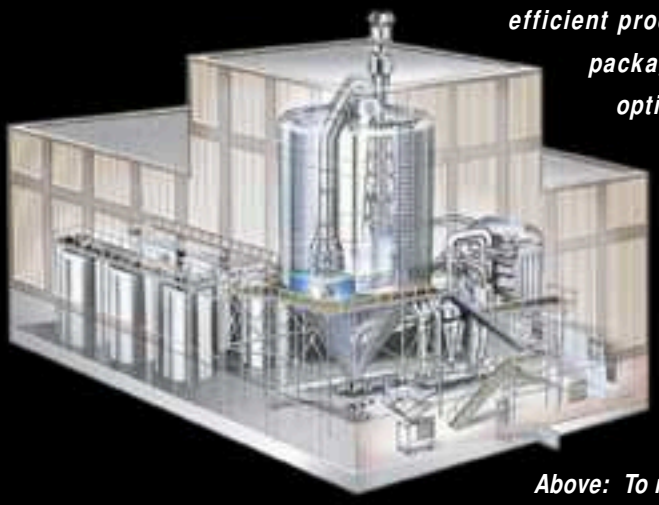
Above: Our powder concentrates, Granufin® low dust granules and Hydrotint® liquids are manufactured to exceed the most stringent quality standards in our industry. We also offer state of the art, turn-key dispensing systems and a variety of efficient product packaging options.



Above: To meet the growing demand for Granufin® granulated colors, we have just completed a new, seven story manufacturing facility. Located in Maryland, Granufin® production in the U.S. will begin January 1998.

What does this mean to you? First, you can expect powder, liquid or granulated pigments with unmatched color, purity and intensity. Second, you'll find Davis Colors leading the way in the development of efficient and innovative pigment metering systems. And third, you'll benefit from a level of dedicated and responsive customer service not found anywhere else.

Since 1952 Davis Colors has concentrated on colors for block, pavers and a variety of concrete products. This singular focus has enabled us to provide our customers with the best products and service available. After all, it's all we do.

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