BAYFERROX®
Color for Life.

Products and Services Available for Manufacturers of Concrete Stone Veneer Products

LANXESS

Introduction

The colored concrete products industry is growing at a rapid pace, with new applications continually being developed. One of the more rapidly growing markets is the concrete stone veneer industry, as witnessed by new manufacturing locations opening regularly across North America. The purpose of this brochure is to inform the stone veneer manufacturer about the products and services available from LANXESS Corporation, and to address some of the production characteristics associated with manufacturing these products.

All product literature referenced in this brochure is available from your Bayferrox® sales representative, or on the web at www.Bayferrox.US There you will find virtually everything about our pigments. Of special note is the Select a Color tab, where the most popular Bayferrox shades are demonstrated side-by-side.

Bayferrox® Iron Oxide Pigments

The pigments that are used to color these products should meet or exceed ASTM® C979, which is the standard specification for pigments for integrally coloring concrete and concrete products. The pigments which pass C979 include synthetic iron oxides, natural iron oxides, chromium oxide green, and some mixed metal oxides including cobalt blue. LANXESS Corporation is the world's largest manufacturer of synthetic iron oxide pigments, marketed under the trademark Bayferrox, a registered trademark of Bayer AG, Germany.

Each manufacturing location for the Bayferrox pigments has ISO® certification, which is your assurance of quality since each step in the manufacturing process has been strictly outlined. We also produce chrome oxide green pigments, and sell a line of natural iron oxide pigments. See the LANXESS publication, *"Inorganic pigments from LANXESS Corporation in North America,"* for more information on our history and products, and *"It's Your Choice. Colors for Concrete,"* our color card that features many of our standard colors.

There are three primary Bayferrox color groups: red, yellow, and black, and within each color group there are numerous shades. For example, reds range from yellowish to bluish shades, and blacks go from those with a brownish undertone to those with more bluish tones.

To make brown colors, precise amounts of two or more of the primary colors are blended together in specialized equipment following strict formulas. For many producers of stone veneer products, the following standard brown blends produced by LANXESS are very popular: 6593, 605/30, 960/4 and 610. Primary colors preferred by this industry include red 110 and 130, and black 330.

In addition to making pigments, LANXESS has a blending and special-size packaging facility in western Pennsylvania. The blending process is described above. Special packaging includes weighing and bagging standard and custom size amounts for all colors, or using different types of bags—like those that disintegrate in the mixer—for the ready mix concrete industry. This facility, and four others like it around the world, is responsible for meeting the local market demands for custom colors and packaging options.

Creating Your Own Brown Blends

For stone veneer companies that do not wish to inventory numerous Bayferrox brown blends, it is possible to create their own brown powder pigment blends using three or four primary colors. Talk to your Bayferrox sales representative for more specific information.

Mortar Colors for Stone Veneer

Provide an additional service by shipping Bayferrox mortar colors in 1, 4 or 25 pound bags along with your veneer stone, and watch your sales grow. Choose your own colors, or let us help you choose colors from the Bayferrox color card that match, contrast or highlight your products. In addition to the pigment, mortar strip kits for your office and mortar color cards for your customers are available from LANXESS.

Product Availability and Order Placement

All Bayferrox colors featured on our color card are available in various warehouses across the country. These colors, and custom blended colors, are available in special sized bags. Talk to your Bayferrox representative about product availability, required lead times and order quantities. Once you have determined exactly what you need, orders can be place by calling 1-800-LANXESS (526-9377) or by using our 24/7 on-line ordering tool called LANXESSOne.

Raw Materials and Mix Design for Concrete Stone Veneer Products

The raw materials that are used to manufacture concrete stone veneer products can vary widely by region and desired properties. As with all concrete products, Portland cement is used. White, gray or a blend of these cements can be used, depending on the desired color of the finished product. Since the product is generally nonstructural, lightweight aggregates can be used to make the final product lighter to handle and easier to install. These would include pumice, expanded shale, or other porous aggregates. Also, regular weight materials such as river sand and gravel can be incorporated in the mix design for improving strength properties. The cement content is typically 20-25%, or a 1:3-4 cement-to-aggregate ratio.

Admixtures can be used to help optimize the mix design. The most common type is a plasticizer. Also known as a water reducing admixture, they reduce the quantity of mixing water needed in the concrete mix while maintaining a high level of workability. The reduction of water increases the final strength

of the concrete product. Water-reducing admixtures may also result in a darker color appearance due to a denser concrete surface that has fewer pores which reduces light scattering.

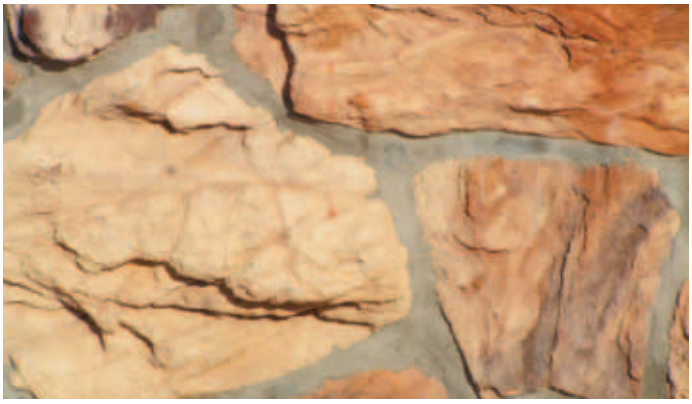
For more information on surface texture, light scattering and color perception, see the LANXESS publication, "*Your Guide to Using Bayferrox Pigments to Color Concrete Products*."

Base Mix Manufacturing

The concrete base mix, which is the mix that makes up the body of the concrete stone veneer, is usually colored integrally with a pigment loading of 1-3% by weight of cement to give the stone its base color. In order to achieve proper dispersion of the pigment for the body color, it is important that the pigment is mixed properly. Here is the recommended mixing sequence to ensure proper dispersion of the pigment:

1. Add aggregates to mixer (pre-wet should be added for lightweight aggregates)
2. Add pigment
3. Mix for 30 seconds, minimum
4. Add cement
5. Add remainder of mix water
6. Mix until homogenous (at least 3 minutes total mixing)

Following this mixing procedure should eliminate any problems with incomplete dispersion of the pigment, such as streaking or spots of pigment.



Molds

The molds that are used to make the concrete stone veneer products can be made out of many different materials, but polyurethane is the most widely used. Polyurethane rubber molds are flexible for ease of de-molding. They are also very durable, and can last for hundreds of castings. Polyurethanes can also capture the intricate textures of the casting stones with great detail, which is a key to creating a more realistic-looking product.

Surface Accent Colors

One of the primary methods of making the stone veneer appear realistic is to create accent colors on the surface of the concrete stone. These accent colors provide a veined or marbled look, very similar to certain types of natural stone. Accent colors are achieved by applying different colors to the molds prior to adding the concrete base mix into the mold. When the cured concrete stones are de-molded, these colors appear on the surface.

There are many different techniques for creating these accent colors, and each provides different color effects. The two most common techniques are discussed below. In addition, when combining different accent colors with various base mix colors, many different color schemes in the final product can be created.

It is important that either accent color technique uses a mixture of pigment and cement. An application of pure pigment, or pigment and water only, can result in poor color adhesion to the finished product. It may be possible to replace the Portland cement with another bonding agent, such as an acrylic or latex emulsion.

1. **Dry shake mix** – This method involves making a dry mixture of pigment and cement. The amount of pigment to cement can vary depending on the desired effect, but a good starting point is 2 parts Portland cement to 1 part color pigment. This mixture should be well blended with a high speed blender or mixer to ensure the mixture is homogenous. The mixture is then applied to the mold with a large salt shaker or sifter in the areas of the mold that are desired to be accented. A portion of fine sand can also be added to aid in blending the pigment with the cement. This technique usually results in a very distinct and vibrant accent color. The amount of pigment that is used in the mixture can be varied to adjust the intensity of the color. Also, it is recommended that the dry shake mix be misted with water after it is applied to the mold to promote adhesion to the base mix.

2. **Wet brush mix** – This method involves making a mixture of pigment, cement and water, which is applied to the mold with a paint brush in the areas of the mold that are desired to be accented. The mixture can be blended in a bucket with a stir motor. The batch size should be kept relatively small, since it can only be used for approximately 30 minutes (the cement hydrates and begins to set up). A portion of fine sand can also be added for texture and improved mixing properties. This technique usually results in a muted, less vibrant color which blends into the base color.

Product Consolidation/Vibration

Once the accent colors have been applied to the mold and the base mix has been poured into the mold, it is necessary to vibrate the molds. The vibration will help to further consolidate all raw materials, remove unwanted air pockets, and eliminate the surface air bubbles on the product. Also, this vibration promotes a blending of the surface accent colors and base mix, which is necessary to hydrate the dry shake mix (if used). This vibration is generally done by placing the molds on a vibrating table that is part of the production line. The amount of vibration necessary can vary depending on the raw materials, mix design, and vibrating frequencies that are used.

Curing

The curing process is a very important aspect of concrete stone veneer manufacturing. Therefore it is important to understand how concrete cures.

Hardened cement paste is formed from the reaction when water and cement are mixed together. This reaction produces calcium silicate crystals of various sizes depending on the curing temperature of the concrete. As the curing temperature increases, the crystal structure of the concrete becomes more irregular. This results in more porous concrete, which increases light scattering on the surface, and results in a lighter color appearance of the concrete. This color difference is most apparent when concrete is cured at elevated temperatures compared to concrete cured at ambient temperatures.

The curing of the stone veneer units is based on the temperature and humidity conditions of the curing environment. It is very important that the curing conditions remain consistent during a production shift, especially in the first 4-8 hours of curing, otherwise there can be variations in the final color of the product. The best way to help ensure consistent curing is to use a curing chamber with temperature and humidity controls. These chambers should have the dimensions necessary to hold no more than 4 hours of production; several chambers will be needed depending on your production capabilities. This will help ensure good color consistency of the stone veneer product. The temperature should be held in a range of 100-140 degrees Fahrenheit and with a relative humidity of 90-95% for excellent strength characteristics of the cured product. The concrete stone should remain in the molds for at least 12-18 hours. At this point, most of the cement has hydrated and it would be safe to remove the product from the mold.

A much simpler method of curing is to cover the filled racks with an insulation blanket, which contains the moisture and heat that are emitted during hydration. This method will work but it is very difficult to control since the ambient temperature will change throughout the seasons in the year. This can result in inconsistent color in the final product.

Product Placement and Durability

Once the stone veneer product has been cured and stripped from the molds, it is packaged for sale. Once installed, the veneer stone is at the mercy of its environment and Mother Nature, and some changes in its appearance can be expected.

If the product is installed in an environment subject to a lot of dirt and dust, these fine particles will accumulate on the stone and cause the appearance of a color change. Another change to be expected is surface erosion. The top surface layer of the stone veneer product is primarily the hardened cement paste. This hardened cement paste will start to wear off with exposure to rain and wind, thus removing some of the pigment color from the surface. The sand and aggregates will now start to be exposed, and their color will now be more visible. This will generally result in a lighter appearance, or a perception of "fading" of the surface color, since the color of the sand and aggregates are usually lighter than the cement paste color. The inorganic pigments used to color the stone veneer products, however, which meet the ASTM® C979 requirements mentioned earlier, do not fade.

Another possible surface change to stone veneer could be caused by efflorescence. Efflorescence is a surface effect caused by a reaction of free calcium from the Portland cement with carbon dioxide in the air. This reaction forms a white substance called calcium carbonate, which can make the surface appear faded or washed out. Efflorescence normally occurs when moisture penetrates the concrete, dissolving some of the free calcium particles forming calcium hydroxide. When the stone veneer starts to dry, the water migrates to the surface through tiny pores in the concrete. This carries the calcium hydroxide to the surface, which allows for it to be exposed to carbon dioxide in the air, and the efflorescence occurs. This process will stop when all of the free calcium particles have been reacted. Efflorescence will eventually dissolve on its own with exposure to more moisture or rain cycles, but this can take some time (2 years or more). Efflorescence can also be removed from the surface of the stone veneer with cleaning products designed to remove efflorescence. For more detailed information on efflorescence, see the LANXESS brochure entitled "*Efflorescence. A Temporary Problem*."

There are ways to address these surface issues. To improve the durability of the concrete stone veneer surface, a sealer can

be applied. There are many types of sealers for concrete. Some form a protective coating on the surface while others penetrate into the surface, providing longer lasting protection. Sealers will help delay surface erosion and can help eliminate efflorescence by not allowing water penetration. Unfortunately, any sealer will eventually wear off with weathering (anywhere from 1-5 years, depending on the type and the weather conditions), and may have to be reapplied.

The most important thing that can be done to improve durability and prolong the life of the concrete stone veneer product is to manufacture a good quality product. This means using the proper pigments and raw materials, a good mix design that results in a dense concrete product, plus proper manufacturing techniques and curing conditions, to give the concrete stone veneer superior strength and appearance.

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