Automatic Concrete Colouring with Pigments - Powder and Liquid

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1. Introduction

Today concrete is one of the main materials in many areas of the building industry.

In the past only the physical properties of concrete were taken into consideration. But concrete is grey and buildings, bridges, streets and pavements appeared uniform and depressing.

In order to obtain a more beautiful and aesthetic concrete, it has become necessary to colour grey concrete.

Todays' forms and colours of concrete are more and more essential in the concrete industry.

The only method to obtain coloured concrete which will retain its colour for decades is the through-colouring of the concrete, the addition of pigments to a concrete mixture of sand, gravel, cement and water.

The pigments used for colouring concrete have to meet some very strict requirements. They have to be lightfast, resistant, stable within wide ranges of temperature and last, but not least, resistant against concrete with its high alcalinity.

These conditions are fulfilled by inorganic pigments like metal oxides (e.g. iron, chromium, titanium) or carbon.

These substances are solids and insoluble in water and in concrete. The colour impression is brought about their homogeneous fine distribution in concrete, by the complete coating of the cement hydrate gel particles.

Pigments can be added to the concrete mixture as a powder or in aqueous dispersion.

2. Manual Addition of Pigments

Of course it is possible to add pigments manually. Every mixer cycle a workman can add a certain weight of powder pigment or a certain volume of aqueous dispersion to the concrete mixture.

However, you must be aware that there are a lot of sources of error, using this method. This can result in the production of substandard material and reduced productivity.

Fig. 1

Manual Addition of Pigments

The major Sources of Error

Powder Pigments	Liquid Pigments
The accuracy of the balance	Measurement of the volume
Dosage by volume	Differences in pigment concentration
Flow behaviour	Drying up of suspension

Time of addition

Point of addition

Powder must be weighed. This means that human error is almost to be expected. In order to get round the bother of weighing out pigment a certain volume of pigment is dosed. Since almost every bag of pigment you take off a pallet has a different bulk density, depending on how many bags were lying on top of it, the same volume of pigment very rarely contains the same weight. Powder pigments do not flow very freely so that when they are emptied into the dosing equipment, they tend to stick to the walls. This means that too little powder may be dosed.

As far as aqueous dispersions are concerned you may often find that aqueous dispersions you make yourself are not homogeneous. As a result you either dose too much water or too much pigment depending on how you get the aqueous dispersion out of your tank and whether you stir it all the time.

Even if you use commercially available aqueous dispersions which contain additives to keep the pigment in aqueous dispersion - if you use a bucket to dose the aqueous dispersion and don't clean it out occasionally - the aqueous dispersion will dry onto the sides of the bucket. These dried-up bits of pigment land in your concrete mixture and turn up later in your pavers as unsightly pigment lumps.

ether you are dealing with powders or quids one of the disadvantages of manual dition is that the pigment may be added to e mixture at the wrong time for example, too te together with the cement, or at the wrong ace. The result is the same - the pigment is t well mixed in the concrete so that you're ft with substandard products on your hands.

e mistakes which arise due to manual dition may be very costly. You can't expect man beings to be like robots - everybody kes mistakes. That's why dosing and other ch monotonous tasks are better carried out tomatically by real robots.

. Automatic dosing equipment

y using automatic dosing equipment it's most as easy to make coloured concrete as rey concrete.

Fig. 2 Automatic Dosing Equipment

Feeding from big storage containers

- Less work
- Accurate, reproducible dosing
- Electric, electronic control
- Uninterrupted mixing cycles
- Right time of addition
- Right point of addition.

The dosing equipment should be attached to large storage containers so you produce continuously without interruption for a long period of time.

By using electronic balances or volumetric measuring systems, you can be sure that you are dosing exactly the same amount of pigment each time and that your final products will all be the same colour too.

The controls can be integrated electrically or electronically in the mixer controls so that the mixing time remains the same.

You can also choose the best moment and the best place to add the pigment, in order to ensure optimal distribution in the concrete mix.

These advantages of automatic dosing equipment apply both for powder as well as for aqueous dispersions. The following displays their differences.

Fig. 3 Basic Dosing Systems

Powder pigments conveyor	Aqueous dispersions
Balance	Sensor volume measurement
Container balance	Dosing cylinder
Differential balance	Throughflow measurement

The commonly used systems for dosing pigments are the conveyor balance or the container balance. In both cases the powder is transported from the silo to the balance by a screw conveyor or a jolting chute.

The conveyor balance empties the pigment automatically onto the aggregate. The container balance feeds the pigment to another conveyor belt or tip, which then brings it to the aggregates.

Differential balances register the amount of pigment leaving the silo. This pigment is then again transported to the aggregates on a conveyor belt or tip.

Aqueous dispersions, on the other hand, are usually dosed volumetrically by filling a cylinder up to a predetermined sensor level, by filling a calibrated dosing cylinder or by using a flowmeter.

Flowmeters are generally pretty inaccurate. Inductive systems are very sensitive to differences in conductivity in aqueous dispersions and mechanical systems are damaged by the abrasive action of the aqueous dispersions.

The main differences between powder and aqueous dispersion dosing systems are the following :

Fig. 4

Comparison of the Dosing Systems

Equipment Factors

	Powder Pigments	Aqueous Dispersions
Equipment parts	many	simple
Space required	large	small
System	open	closed
Worker protection	difficult	good
Controls	easily integrated but complicated	easily integrated and easy
Storage tanks	silos	tanks or containers
Costs	DM 60,000.-- DM 150,000.--	DM 10,000.-- DM 60,000.--

Powder dosing systems are made up of a range of high-precision mechanical parts - for example - for the transport of the pigment to the weighing unit and from there to the aggregates and the weighing unit itself.

They usually take up a lot of room, with a surface area of several square metres and several metres in height.

For each colour you need a separate silo and a transport unit to the weighing unit. In the case of the differential balance, you have to install several balances.

The dosing system for aqueous dispersions are smaller than the powder systems and can, in almost all cases, be installed directly above or near the mixer. Simple standard pumps transport the colour to the dosing equipment. The volume required then drops out of the dispenser by its own gravity or it can be pumped to the most suitable point.

You are all familiar with the amount of dust generated when working with powder pigments.

All powder dosing systems are open systems. When you empty powder from big bags or small bags into the silos, and at each subsequent step in the weighing process, dust escapes and gets blown all over the factory. Screw conveyors, jolting chutes, container balances, conveyor belts - they are all open.

And every time they transport the powder th generate a dust cloud.

If you decide to use the aqueous dispersi dosing system, the container which serves packing can also be used as a storage tan Either that or the material can be delivere in road tanker and fed directly through closed tube system into the storage tan without harming the environment in any way.

The suspension then passes through a close system until it reaches the mixer. It is fe through tubes to simple, not very expensiv pumps and the required volume is then added t the mixer. Aqueous dispersions, if use correctly, will ensure that your factory stay clean, that you don't waste any powder b having to throw away torn bags and that you workers don't have to walk around looking a if someone had rolled them in a bag o multicoloured pigments.

The factory inspectorate in most countries ha defined the maximum dust levels permissible i factories in order to safeguard the workers Dedusting plants, uncomfortable protectiv clothing and face masks may also b obligatory. The continuing trend towards mor protection of the environment means that th rules will probably be even more stringent i the future.

The controls for both systems can easily b integrated into the main control unit for th mixer.

Of course the control unit for powder dosin systems tends to be more complicated as th system itself is made up of high-precisio parts. This means that there is mor likelihood of a break down.

Due to the physical properties of powde pigments, powder dosing systems are usuall quite bulky. This is reflected in th relatively high cost of such a system Commercially available powder dosing system cost between DM 60,000.-- and DM 150,000.- while dosing systems for aqueous dispersion are available for between DM 10,000.-- and D 60,000.-- depending on the number of differen colours to be dispersed.

4. Other Aspects of Automatic Pigment Additio

As well as the type of dosing system, variety of other factors play an essentia role when you are considering whether t install a powder or aqueous dispersion system It all depends on what is most convenient fo your factory.

Fig. 5

Other Aspects of Automatic Pigment Addition

	Powder	Aqueous Dispersions
Type of packing	25 kg bags big bags	drums container 600 l 1,000 l, road tanker
Type of storage	in a shelter	outside (in winter with anti-freeze)
Handling in the factory	difficult to stack	easy to stack
Special equipment	necessary	unnecessary
Feed system	complicated	simple
Disposal of empty packing	by manufacturer	by pigment supplier
Pigment efficiency	not always maximized	very high
Additives - reduction of efflorescence	must be added separately	can be incorporated in the suspension
transport costs	lower	higher

The most important factors are the following : The type of packing, in which the pigments are supplied. Nowadays pigments are nearly always supplied in 25 kg bags or big bags weighing up to one tonne. Regardless of whether you intend to use a powder dosing unit or liquefy your pigments yourself, the original packing is unsuitable as a storge container. This means that the powder must be filled into another container, thus allowing a lot of dust to escape into the factory.

Aqueous dispersions can be supplied in drums containing up to 75 kg, 600 l and 1,000 l container or in road tankers.

Pallets with powder pigments - small or big bags - even when shrink-foil wrapped should not be stored outside and cannot be stacked on top of one another. If powder pigment is left out in the rain it clumps and cannot be mixed evenly with the concrete.

Containers of aqueous dispersion can be stacked two at a time and can be stored outside, at least as long as there is no frost.

If you want to store the containers outside in winter, the aqueous dispersion must contain anti-freeze.

If you want to transport big bags in your factory on your fork-lift truck you usually require a special handling device. It can be quite an adventure too, trying to transport a pallet of 25 kg bags once the shrink-foil has been removed. Compared to that it really is much easier to handle the containers of aqueous dispersion screwed onto their pallets.

When you use powder pigments you have a lot of extra work and dust production filling them into storage silos, even if you make your own aqueous dispersions, whereas aqueous dispersions supplied in containers are ready-to-use. All you have to do is connect the container to the dosing system with a tube.

With powders you also have the additional problem of what to do with the empty bags. On the other hand, empty containers can be sent back to the supplier.

Another important aspect is the pigment efficiency - that is the tinting strength you can expect from your pigment in the final concrete product.

This is the only thing that matters to the concrete manufacturer. You don't really care about the solid content or the volume of your pigments, just as long as the final colour is good. However, in order to have a high tinting strength, the pigment must be well dispersed in the concrete mixture. In the case of powder pigments this dispersing action only takes place in the mixer when it is added to the aggregates. The pigments are ground down by the aggregates, sometimes more, sometimes less, so that you never know whether your pigments have been fully dispersed or not. The same applies for aqueous dispersions you make yourself, by adding pigment to water.

Commercially available aqueous dispersions, on the other hand, have been well dispersed during manufacture so that you're getting the full tinting strength every time. This is because they have been passed through a dissolver and a mill. The pigment suspension also contain additives - 1 to 3 % by weight - such as wetting agents, dispersing agents, milling aids and stabilizers. These ensure that commercially available aqueous dispersions have a higher tinting strength per kilo of powder pigment than powder pigments themselves and to not sediment easily.

Additives such as anti-efflorescence systems can be added directly to the aqueous dispersion by your pigment supplier, thus saving you from having to add it separately before use.

As I mentioned before, the only thing that really matters to the concrete manufacturer is the final colour of his product. This means that the solid content of a suspension may not always be an indication of the tinting strength. If only half the solid content is pigment and the other half is colourless filler, the tinting strength only comes from the pigment, not from the filler.

Depending on the size of your operation it may be worthwhile for you to liquefy your own pigments, so that you can benefit from at least some of the advantages of aqueous dispersions. However, you must weigh up the advantages and disadvantages of making your own slurry or buying it very carefully. After all, it does involve more work and home-made aqueous dispersions do tend to sediment rather easily.

You often hear the argument in favour of liquefying yourself- after all, you don't want to pay for having water carted around -. So it's a little more expensive but nothing in life is free. If you want to have good products, you have to pay for them. Commercially available aqueous dispersions have a high, reproducible tinting strength, they're easy to dose, they can be stored easily so that they're well worth the extra money you have to pay for them.

What I've tried to do today is give you some idea of the advantages and disadvantages of using powder or liquids. Even though liquids are very convenient to use, it all depends on your factory. Maybe powders are better for you. However, what I recommend in any case is that you take all factors into account - not just the kilo price of the pigments.

I hope that I've been able to give you some information on the automatic dosing systems available today and thank you for listening to me.