NEW PIGMENTS FOR THE COLOURING OF CONSTRUCTION MATERIALS PROCESSING ADVANTAGES AT ZERO TARIFF

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ABSTRACT

For colouring of concrete in many shades iron oxides are well established in the concrete industry. Nowadays the user not only has the choice of variation of colours from red, yellow and black to a spectrum of brown, but also of different forms of preparations: the traditional pigment powder, slurries ready for use or produced on site or most modern, pigment granules.

The different parameters of the above mentioned products will be summarised which define the quality of coloration of cementitious or lime bound building materials.

A new delivery form for pigments will be presented. Compact pigments were purposively developed for the colouring of construction materials. They are applicable universally in the same way as powder pigments, at the same time, however, are flowable and low in dust emission similar to granulates.

The dispersibility in finely graded construction material is indicated on examples. The flowability permits a rapid and reliable use in metering installations. Compact pigments (trade name Bayferrox® C) satisfies the requirements of DIN 53 237. It is being offered at the price of powder goods; the applicational advantages are, therefore, utilisable at zero tariff.

1 CHOICE OF PIGMENTS FOR COLOURING CONCRETE

A great lot of publications in the past have dealt with the general basic requirements for pigments for colouring of building materials. The practice results of decades have proved that oxide pigments of iron, titanium, chromium, mixed metal oxides exhibit excellent properties in concrete. Meanwhile also a lot of national and international standards exist from which advice can be taken for choice of the right sort of pigment. Pigments for which the manufactures certify the general suitability in accordance with such norms are, for sure, a good selection; such materials will be insoluble in water and the alkali of the cement, will not influence the concrete strength and setting, will be stable in weather and have uniform colour and tinting strength – in one sentence: they fulfil the basic general requirements for colouration of concrete.

But this is only one aspect; the next choice to be made now concerns the form of delivery. Meanwhile, besides the traditional form of pigment powder also fluid preparations (water-borne slurries) and pigment granules or compact pigments are established in the market. A decision for a certain form of supply normally is a decision for a certain method of pigment dosage into the concrete mix – an essential point to be discussed separately. Compact pigments combine the advantage of the up to now available delivery forms. They are:

- flowable and low in dust emission in the same way as granulate and slurry
- as powder universally applicable and cost effective

2 PRODUCTION AND GENERAL PROPERTIES

Starting materials for the production of compact pigments are powder pigments which are processed into a free-flowing bulk material with the assistance of a binder. Compact pigments consist of individual particles which have a diameter of around 0.5 mm. In Table 1 are presented some properties of powder and compact pigments.

Table 1: Powder and Compact pigments in Comparison – Technical Data

	Particle size [µm]	**Bulk density [g/cm³]**
Powder pigments		
Red 110	0.09	0.6
Black 330	0.15	0.6
Yellow 920	0.1 0.6*	0.25
Compact pigments		
Red 110 C	500	1.2
Black 330 C	500	1.1
Yellow 920 C	500	0.6

* acicular particles

3. TECHNICAL PROPERTIES

3.1. Flowability

The good flowability is secured by the particulate structure of compact pigments. Photo 1 compares the flow behaviour of powder and compact pigments. The powder pigment clogs up the exit opening of the feeding hopper already in the filling operation. The compact pigment, on the other hand, flows out uniformly.

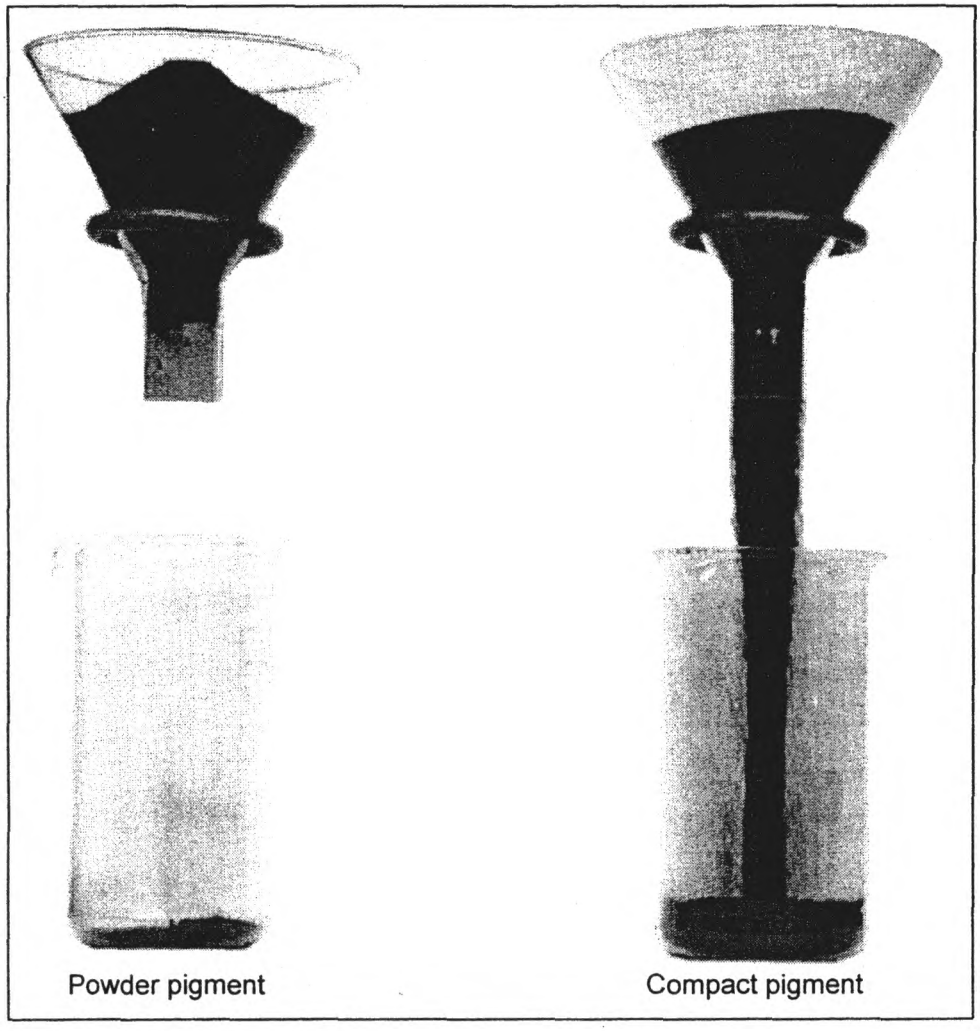

Photo 1: Flow behaviour

Large scale tests confirm the good flow behaviour. Table 2 sums up the results of tests on the emptying of the delivery containers. Both as regards the run-out time as well as with regard to the residues remaining in the containers, the compact pigments behave more favourably than powder pigments.

Table 2: Emptying of Containers

	25-kg Paper bag	**1-t Bulk bag**	
	Residue [g]	**Residue [g]**	**Run-out time [min]**
Powder pigment	50	350	2 – 3
Compact pigment	10	50	0.5

3.2. Dispersion behaviour

The prerequisite for the universal usage is the dispersability even under difficult dispersion conditions. With a decreasing particle size of the aggregate the necessary dispersive effort in general increases.

In finely graded dry mixes (mortar, rendering material, sand-lime bricks or blocks) even powder pigments are difficult to disperse. The following examples (Figure 1, Table 3) show that compact pigments are fit to use even in these systems.

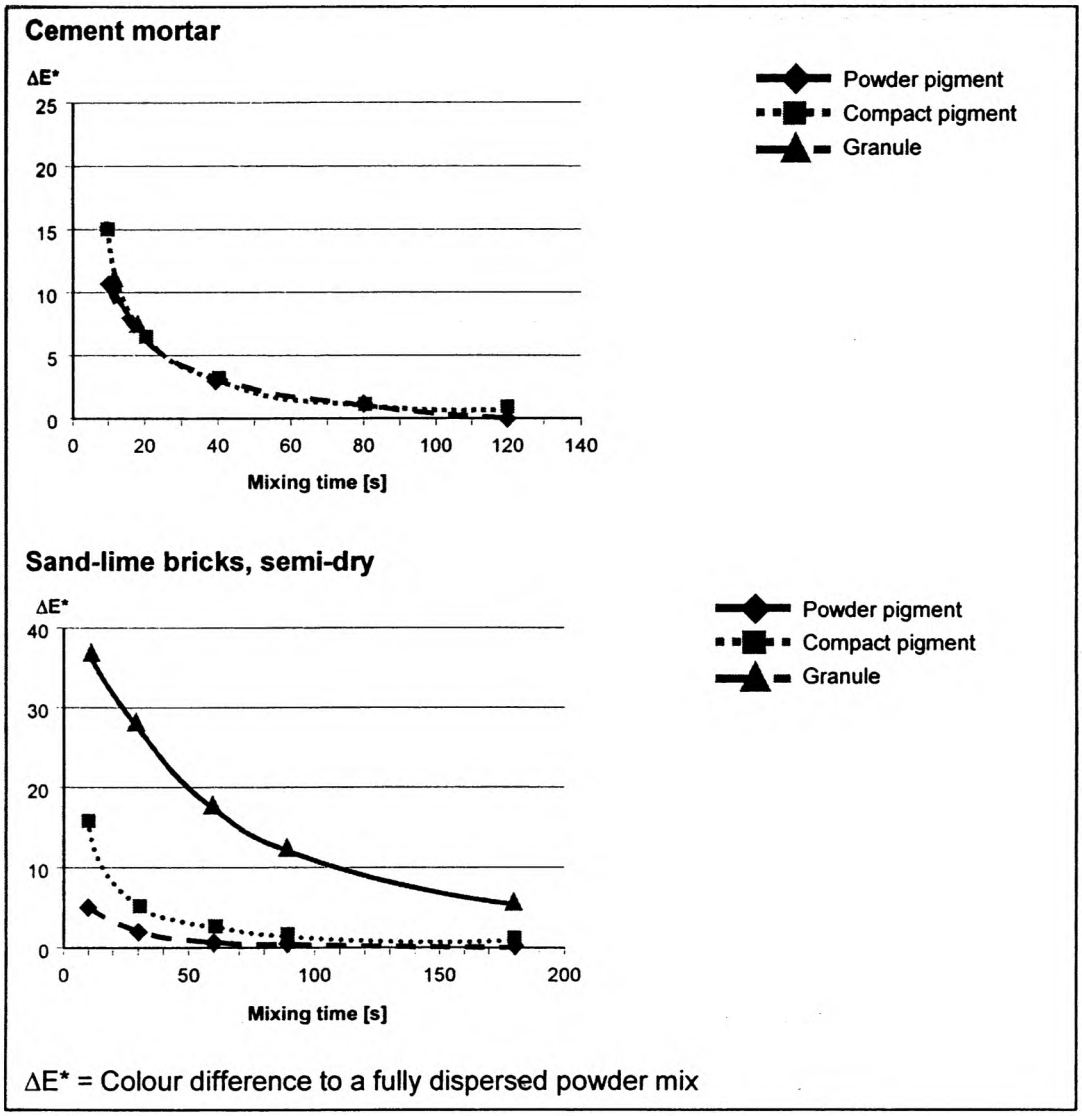

Figure 1: Dispersion behaviour

Table 3: Dispersing Tests – Recipes

1 Cement mortar	
Limestone dust	10 parts by wt.
Quartz sand (0.2 – 1 mm)	60 parts by wt.
Quartz sand (1 – 2 mm)	30 parts by wt.
Aggregate	100 parts by wt.
White cement (CEM I 42,5R)	25 parts by wt.
Water/cement ratio	0.35
Pigmentation*	1.2 %

2 Sand-lime brick mix	
Quartz sand (0 – 1 mm)	80 parts by wt.
Limestone dust	10 parts by wt.
Hydrated lime	10 parts by wt.
	100 parts by wt.
Pigmentation**	1 %

* related to cement content
** related to total mix

For the determination of the dispersion behaviour mortars were pigmented with powder and compact pigment. The mortars were made up in laboratory mixer at a low rate of rotation and for a range of different mixing periods. From the finished mortars were prepared pressed specimens the colours of which were determined after curing. The degree of dispersion is judged by the colour differences ΔE between individual mortar specimens and a specimen in which the pigment is present in a completely dispersed state (powder pigment, 120 s mixing time). After a mixing time of only 20 s the mortars produced with powder and compact pigment become indistinguishable.

The dispersability in semi-dry sand-lime brick mixes was determined similarly. Under the dispersion conditions usual in practice, i.e. with mixing time periods longer than one minute, compact pigments are just as well suitable as powder pigments.

Figure 1 shows that granulates cannot be satisfactorily dispersed in such mixes.

The here described laboratory tests on the dispersability were supplemented by tests in practice with rendering and mortar producers. It was shown that compact pigments could be perfectly dispersed even in the very finely graded jointing mortars.

4. COLOUR RANGE – ADDITIVE METERING

The range of the compact pigments is limited to seven types. This limitation was intentionally adopted in order to keep down the production costs by a quasi-continuous technique. The Compact pigments are offered at the price by powder pigment.

The Compact pigments can be mixed with each other in optimal ratios in the same way as powder pigments. In this way can be produced a wide-ranging colour shade palette. Photo 2 shows the possibilities which can result from the use of the three basic pigments 110 C, 330 C and 920 C. In this colour triangle are marked the positions for 965 C and 615 C. Additive metering was already the subject of a report published elsewhere [1]. It is practised already today in many concrete works.

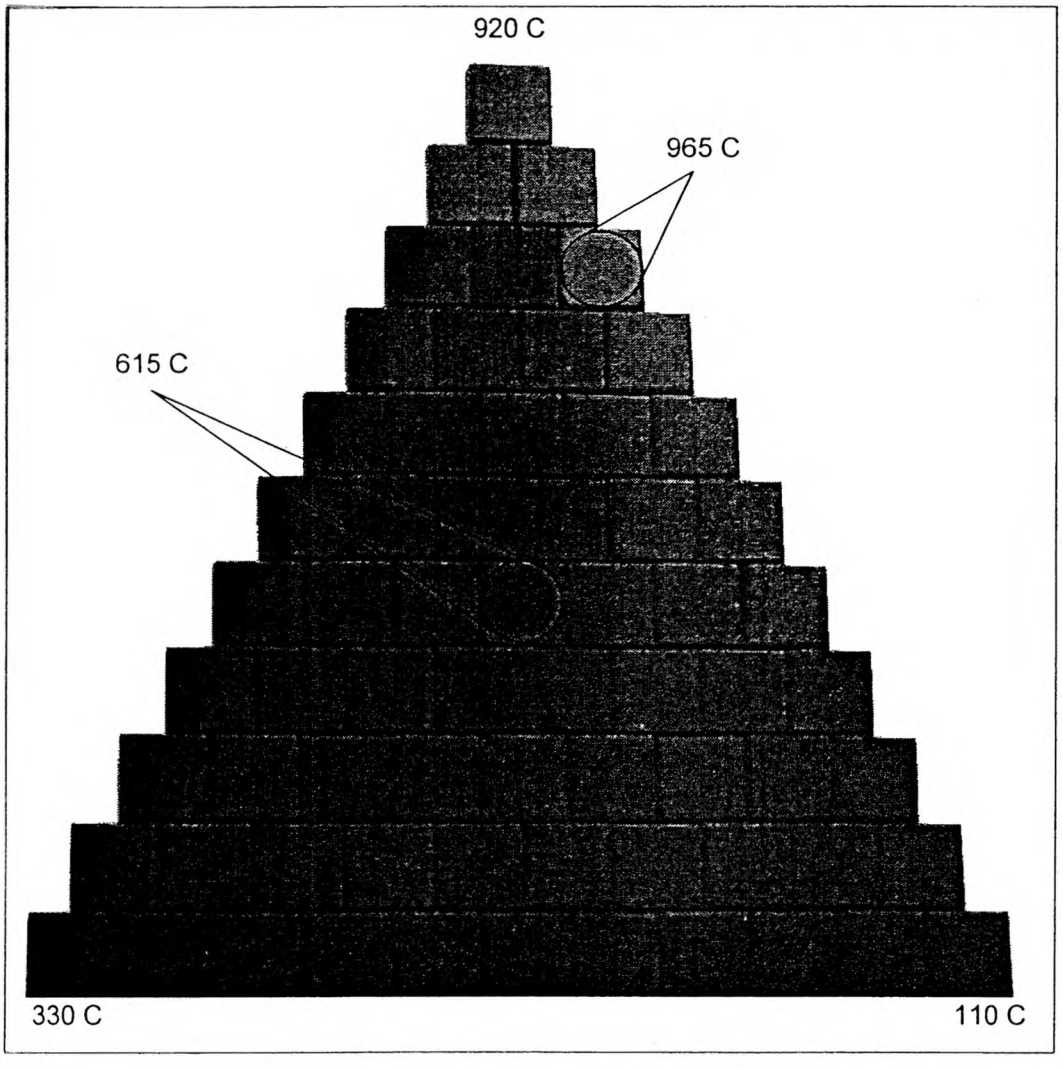

Photo 2: Colour diversity by additive metering

The flowability of the compact pigments improves the accuracy of pigment metering. The additive gains thereby in safety and reliability.

5. PROCESSING

Compact pigments can be used in the same way as powder. Powder metering installations can be operated more simply and more reliably with compact pigments than with powder pigments.

Also the in-house-production of slurry is possible with compact pigments. The binder has a slight plasticising effect. The flowability of the suspension is thereby improved.

With regard to the concrete preparation (mixing time, order of addition), compact pigments can be handled in the same way as powder pigments.

SUMMARY

A new delivery form for pigments is presented. Compact pigments were purposively developed for the colouring of construction materials. They are applied universally in the same way as powder pigments, at the same time, however, are flowable and low in dust emission similar to granulates. The dispersibility in finely graded construction material mixes is indicated on examples. The flowability permits a rapid and reliable use in powder metering installations. It is being offered at the price of powder goods; the applicational advantages are, therefore, utilisable at zero tariff.

REFERENCES

1. G. Büchner, K. H. Turban, "Efficient Manufacture of Coloured Concrete Products", BFT Betonwerk + Fertigteil-Technik ("Concrete Prescasting Plant and Technology"), issue 8/96, pages 86 - 94