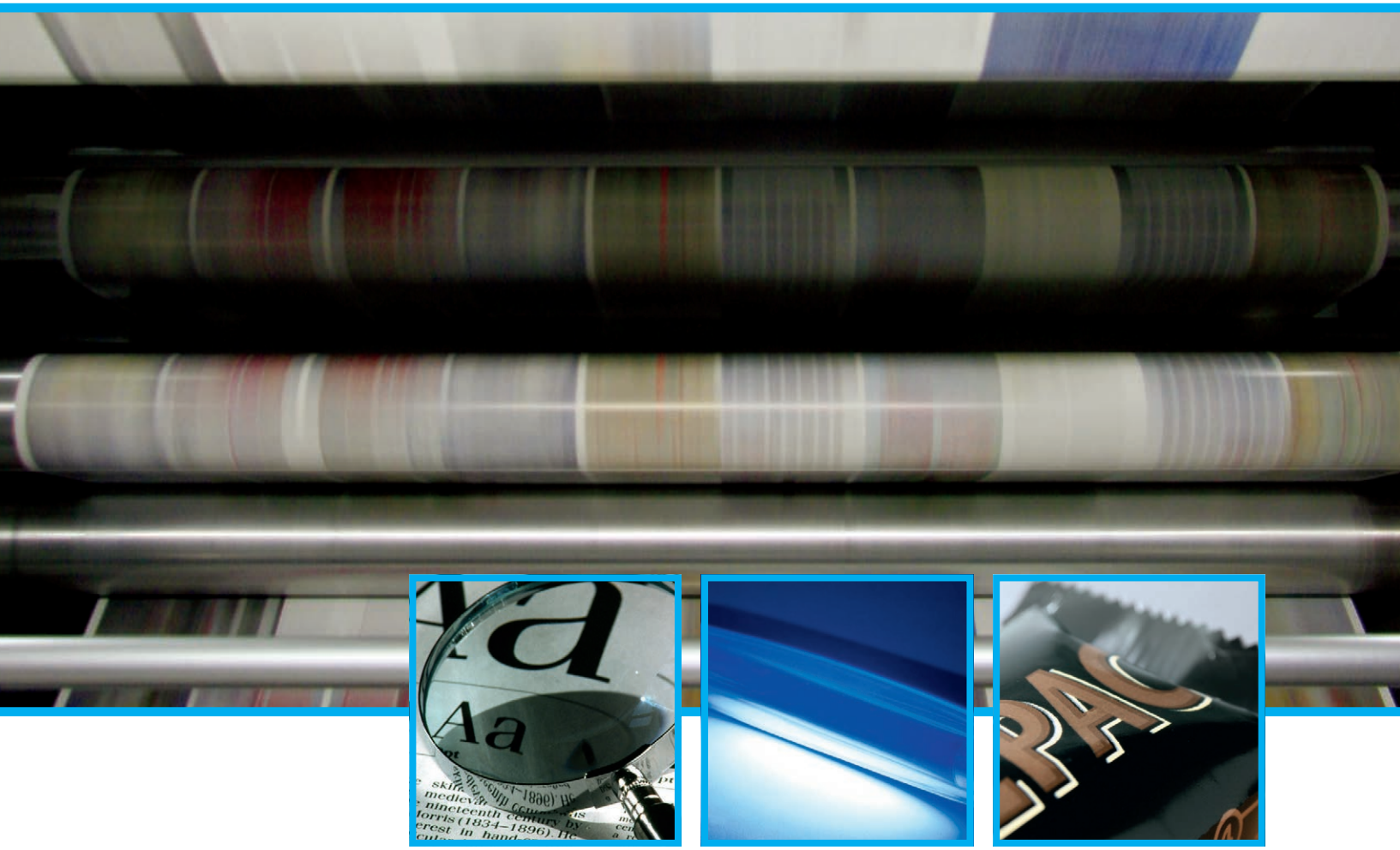
Carbon Black Pigments for printing inks

Industry Information



orion ENGINEERED CARBONS

Content

1. Introduction

This brochure provides an overview as well as specific information regarding the products of Orion Engineered Carbons that are recommended for the use in printing ink applications in the Americas, Europe, Africa and Near Middle East.

Using various technologies, Orion Engineered Carbons produces specially designed fine-particle Carbon Black Pigments.

2. Basics of Carbon Black Pigments for use in printing ink applications

Although the trend in recent years has been towards increased use of colored printing inks, approximately 100,000 MT per annum of Carbon Black Pigments are used worldwide for manufacturing printing inks. There are compelling reasons for the use of Carbon Black Pigments as the pigment in black inks. Their high efficiency in combination with excellent fastness at relatively low cost benefits printing ink manufacturers. Orion Engineered Carbons is the only supplier that has four different process technologies (the furnace black, Degussa gas black, lamp black and the thermal black processes) to draw from and can thus offer Carbon Black Pigments with properties which can be tailor-made for different aspects of printing ink formulations. These products are supplied to printing ink manufacturers under the trade names PRINTEX®, NEROX® and SPECIAL BLACK.

The most important features of Carbon Black Pigments are the size of the pigment primary particles and the structure of the aggregates. These parameters define the coloristic properties such as undertone, optical density, gloss and also the rheological effect of the Carbon Black Pigments and their dispersibility in binders.

Irrespective of the print technology, properties of the printing ink are strongly influenced by the primary particle size and structure of a Carbon Black Pigment. For film thicknesses of less than 10 µm, typical for printing inks, the following relationships are valid:

- The smaller the primary particle size, the higher the optical density of the ink film.
- The smaller the primary particle size, the more brownish the undertone of the print.
- The smaller the primary particle size, the higher the viscosity of the printing ink.
- The higher the structure of the Carbon Black Pigment (larger aggregate size), the higher the viscosity of the printing ink.
- The higher the structure of the Carbon Black Pigment, the better the dispersibility.
- The larger the Carbon Black Pigment aggregates, the better the hold-out but also the lower the gloss of the print.

Another important property of the Carbon Black Pigment is the nature of the pigment surface, which depends on the production process. Products manufactured by the Degussa gas black technology already possess a high proportion of volatile components measured at 950 °C, which indicates a high level of functional surface groups. Surface functional groups of a furnace black are the result of a special aftertreatment process. Such products are also part of Orion Engineered Carbons's portfolio of carbon blacks under the names SPECIAL BLACK and NEROX®. The surface chemistry is important for the wettability of the carbon black by the binder, and in this way also influences properties such as ink rheology and gloss. Aftertreated Carbon Black Pigments can be identified by acidic pH values and significantly higher volatile matter contents at 950 °C in comparison to the untreated grades.

As can be seen from this short introduction finished ink performance is determined by a multitude of properties of Carbon Black Pigments and their interaction with the various other fomulation components. Furthermore the choice of the right Carbon Black Pigment is largely determined by the print technology and its special demands on printing ink properties, such as color development, dispersing technology, binder system, rheology, film thickness, ink/water balance, matting or optical density.

3. Flexographic and gravure printing inks for publication and packaging

3.1 Specifics for solvent based printing ink systems

Solvent based flexographic and gravure printing ink formulations have a low viscosity and exhibit particular demands for additives and co-binders. High pigment loadings (usually organic or carbon black) must be perfectly wetted out and stabilized. The most diverse print substrates require quick and efficient surface wetting, and the drying of the ink must be fast.

The varying types of substrates from absorbent board to coated papers or films pose a challenge for the formulator of printing inks for packaging. These solvent based printing inks contain nitrocellulose (NC) often combined with polyamide (PA), polyurethane (PU) or polyvinylbutyral (PVB). When choosing the appropriate black pigment it is important to ensure the correct combination of binders. Although various pigments can be well-wetted with nitrocellulose, the compatibility of the black base with different binders is the decisive factor in determining the final printing ink properties.

Depending on the specific binder combination and requirements of the final printing ink, aftertreated furnace blacks, untreated grades and also gas blacks can be used. In practice, densified or beaded Carbon Black Pigments show advantages such as higher optical density and gloss compared with low-densified products. Recommended Carbon Black Pigments are summarized in **Table 1**.

Publication gravure inks are processed at very high speeds necessitating a very low viscosity of the printing ink. The use of low structured Carbon Black Pigments with relatively large primary particle sizes, such as PRINTEX® 25 and PRINTEX® 35, permits formulation of low viscosity printing inks with excellent coverage, optical density, blue undertone and gloss. For minimum abrasion levels, these grades are monitored with the well-known Burda-tester.

Table 1

Recommended Carbon Black Pigments for solvent based inks

Product	Characteristics	Effects
SPECIAL BLACK 4	RCG* type, aftertreated black used in high jetness packaging inks	Maximum jetness combined with excellent compatibility with PA- and NC-binders in packaging inks
SPECIAL BLACK 350 **NEROX® 3500**	LCF** type, low structured, aftertreated black; used in packaging inks	Excellent flow properties combined with high jetness; superior compatibility with PA- and NC-binders in packaging inks
SPECIAL BLACK 250 **NEROX® 2500**	LCF** type, low structured, aftertreated black; used in packaging inks	Excellent flow properties combined with distinct bluish undertone; superior compatibility with PA- and NC-binders in packaging inks
PRINTEX® 35	LCF** type, low structured black used in packaging and publication gravure inks and ink concentrates	Excellent flow properties combined with high jetness; good compatibility with PU-, PVB-, and NC-binders in packaging inks
PRINTEX® 25	LCF** type, low structured black used in packaging and publication gravure inks and ink concentrates	Excellent flow properties combined with distinct bluish undertone; good compatibility with PU-and NC-binders in packaging inks

* International Classification as Regular Color Gas Black

** International Classification as Low Color Furnace Black

3.2 Specifics for water based printing ink systems

In recent years, water based printing inks have become increasingly important. Extensive work of ink formulators and raw material suppliers has opened the door to truly high quality applications.

The selection of the most suitable Carbon Black Pigment for water based flexographic and gravure inks is mainly dependent on the final substrate and the desired coloristic properties.

In the manufacture of water based inks for flexographic and gravure printing, the pigment can be dispersed as a resin free concentrate or in conjunction with a grinding resin.

High structured furnace black pigments such as PRINTEX® 30 typically feature high optical densities on absorbent substrates like corrugated cardboard. Nevertheless the influence of these

pigments on the flow properties of the printing inks has to be taken into account. Low structured grades, e. g. PRINTEX® 45, give excellent results on non-absorbent substrates such as coated paper or films. These pigments have less effect on the viscosity and therefore allow high pigment loadings.

Table 2

Recommended Carbon Black Pigments for water-based inks

Product	Characteristics	Effects
PRINTEX® 60	RCF* type, high structured black for absorbent substrates	Excellent hold out and therefore highest jetness
PRINTEX® 45	RCF* type, low structured black for non-absorbent substrates	Excellent balance of high jetness and bluish undertone
PRINTEX® 3	RCF* type, high structured black for absorbent substrates	Excellent hold out and therefore high jetness
PRINTEX® 30	RCF* type, high structured black for absorbent substrates	Moderate influence on the rheology; very good hold out and therefore high jetness
PRINTEX® 260	RCF* type, low structured black for non-absorbent substrates	High jetness pigment with low viscosity and good flow properties
PRINTEX® 300	RCF* type, medium structured black for non-absorbent substrates	Moderate influence on the rheology

* International Classification as Regular Color Furnace Black

4. Specifics for radiation curing printing ink systems

Radiation-curing flexographic, screen and offset printing inks are strong growth areas. The general characteristic of Carbon Black Pigments is the absorption of radiation not only in the visible part of the spectrum, but also in the ultraviolet region. The binders used for these inks are already relatively high in viscosity, which is further increased by the incorporation of high surface area pigments. The concept of radiation-curing (i.e. UV-curing) of black printing inks is a challenge due to the fact, that the formulation of radiation-curing black ink needs the Carbon Black Pigment and the binder-system in the formulation to be a perfect match. SPECIAL BLACK 250, a low structured aftertreated furnace black, is Orion Engineered Carbons's main recommendation to these demands. Due to its surface chemistry this Carbon Black Pigment shows excellent wettability and exhibits excellent flow properties. Additionally, printing inks formulated with SPECIAL BLACK 250 show good through-cure combined with good coloristic properties. The full range of suitable Carbon Black Pigments is listed in **Table 3**.

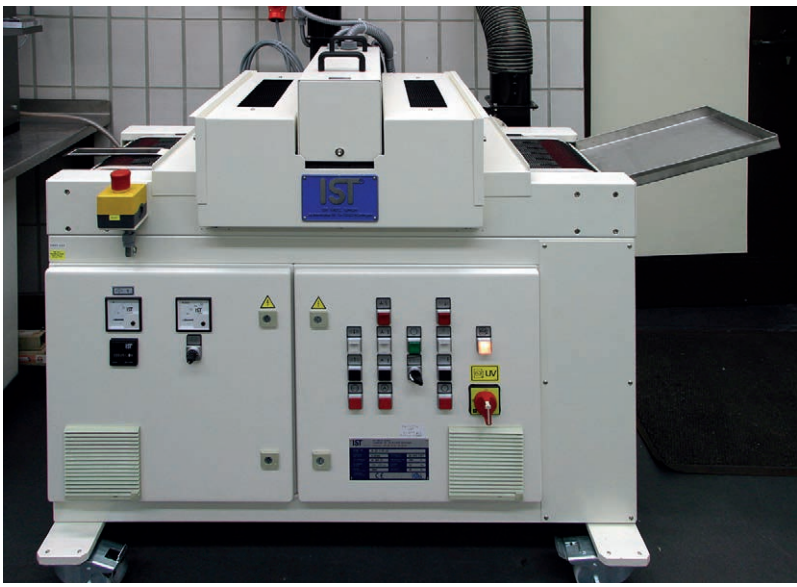
Table 3

Recommended Carbon Black Pigments for radiation curing inks

Product	Characteristics	Effects
SPECIAL BLACK 250	LCF* type, low structured, aftertreated black	Excellent wetting behavior due to surface aftertreatment; little influence on rheology combined with very good through-cure and bluish undertone
SPECIAL BLACK 350	LCF* type, low structured, aftertreated black	Excellent wetting behavior due to surface aftertreatment; little influence on rheology combined with good through-cure and high jetness
NEROX® 2500	LCF* type, low structured, aftertreated black	Excellent wetting behavior due to surface aftertreatment; improved flow combined with very good through-cure and bluish undertone
NEROX® 3500	LCF* type, low structured, aftertreated black	Excellent wetting behavior due to surface aftertreatment; good flow combined with good through-cure and highest jetness
SPECIAL BLACK 4	RCG** type; aftertreated black	Excellent wetting behavior due to surface aftertreatment; high jetness at reduced pigment loading

* International Classification as Low Color Furnace Black

** International Classification as Regular Color Gas Black



5. Specifics for offset printing inks

5.1 Coldset

The very special challenge in formulating coldset printing inks is to achieve excellent optical densities combined with good rub resistance on highly absorbent substrates.

Orion Engineered Carbons offers specialty Carbon Black Pigments for this area of application. The structure of the Carbon Black Pigment has a pronounced influence on the bonding of the ink to the paper substrate. High structured Carbon Black Pigments give an excellent hold-out, and therefore an improved optical density. Lower structured Carbon Black Pigments are able to penetrate into the paper, so that they are well fixed and increase the rub resistance. Unfortunately this penetration has a negative effect on the jetness. To optimize the optical properties as well as the rub resistance of the final print irrespective of the paper quality, printing ink manufacturers often do use blends of different kinds of Carbon Black Pigments.

Additional requirements on Carbon Black Pigments are related to processing like automated production of coldset printing inks where sufficient handling and conveying of Carbon Black Pigments is favorable. Beaded carbon blacks are especially suitable, as they feature little formation of dust and good flow properties. Typical Carbon Black Pigments for this application are PRINTEX® 30 and PRINTEX® 300.

Table 4

Recommended Carbon Black Pigments for coldset inks

Product	Characteristics	Effects
PRINTEX® 30	RCF* type; high structured black	All purpose grade with medium flow properties and jetness
PRINTEX® 300	RCF* type; medium structured black	High jetness achievable; good flow characteristics for high speed presses; lower binder demand for improved rub resistance
PRINTEX® 310	RCF* type; high structured black	Medium jetness pigment with good dispersibility and low loading

* International Classification as Regular Color Furnace Black

5.2 Heatset and sheetfed

Heatset printing technique is suitable for a very broad range of substrates ranging from super calendred papers (SC) through light weight papers (LWC) to coated papers. The formulation of the printing inks, including the choice of Carbon Black Pigments, needs to take this into account to ensure the best possible print quality independent of the paper quality.

Printed media produced with sheetfed printing technique is often high-end, typically on coated paper. High optical densities in combination with high gloss are key requirements.

For the production of such high quality heatset and sheetfed printing inks, low structured Carbon Black Pigments are the products of choice. In some special cases, the usage of aftertreated Carbon Black Pigments improves the flowability. The Carbon Black Pigments mainly used in heatset and sheetfed inks are PRINTEX® 45, PRINTEX® 35 and PRINTEX® 25. All three grades are low structured furnace black pigments that impart good flow properties. PRINTEX® 45, with the smallest primary particle size of the three grades, gives excellent optical density whereas PRINTEX® 25 with the largest primary particle size provides an excellent bluish undertone. PRINTEX® 25 is also suitable for use in combination with PRINTEX® 35 and PRINTEX® 45 to increase the bluish undertone while reducing the viscosity.

Appropriate Carbon Black Pigment grades are listed in **Table 5**.

Table 5

Recommended Carbon Black Pigments for heatset and sheetfed inks

Product	Characteristics	Effects
PRINTEX® 55	RCF* type; low structured black	Highest jetness for sheetfed printing inks
PRINTEX® 45	RCF* type; low structured black	Excellent color properties with medium flow; excellent jetness
PRINTEX® 35	LCF** type; low structured black	High jetness combined with a bluish undertone; good flow; high pigment loadings achievable
PRINTEX® 25	LCF** type; low structured black	Excellent flow properties permitting highest loading levels; best bluish undertone
PRINTEX® 27	LCF** type; low structured black	Strong blue undertone with excellent flow properties and high pigment loading; good balance of optical density and blue undertone
SPECIAL BLACK 350	LCF** type; aftertreated, low structured black	High jetness combined with a bluish undertone; excellent wetting behavior

* International Classification as Regular Color Furnace Black

** International Classification as Low Color Furnace Black

6. Specifics for screen printing inks

Screen printing differs in some respects from other printing techniques, with the most obvious differences being the printing speed and the applied film thickness. Both properties influence the formulation of the printing inks. The higher film thickness applied means that lower Carbon Black Pigment concentrations are needed. The optical density, bluish undertone and the level of gloss are high and the flow properties of the ink have an important influence on the behavior of the ink during application.

For both, solvent based and radiation-curing screen printing inks, SPECIAL BLACK 4 is the product of choice for excellent optical density and gloss. In water based systems PRINTEX® 60 is recommended. SPECIAL BLACK 250 is the preferred solution for low viscosity UV curing systems and PRINTEX® 25 for either solvent based or water based ink formulations.

Table 6

Recommended Carbon Black Pigments for screen printing inks

Product	Characteristics	Effects
SPECIAL BLACK 4	RCG* type; aftertreated black used in solvent based and radiation-curing screen printing inks	Excellent wetting behavior due to high degree of surface functional groups; excellent jetness combined with good through-cure and optimized flow in flat bed screen inks
SPECIAL BLACK 250	LCF** type, low structured, aftertreated black; used in solvent based and radiation-curing screen printing inks	Excellent wetting behavior due to surface functional groups; excellent flow combined with very good through-cure and bluish undertone
PRINTEX® 60	RCF*** type, high structured black	High jetness in water based flat bed screen inks
PRINTEX® 25	LCF** type, lowest structured black	Good flow in solvent based and water based rotary screen inks

* International Classification as Regular Color Gas Black

** International Classification as Low Color Furnace Black

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The Americas
Orion Engineered Carbons LLC
4501 Magnolia Cove Drive
Suite 106
Kingwood, TX 77345 USA

phone +1 832-445-3300
fax +1 832-445-0250
at-ink@orioncarbons.com

Europe / Middle East / Africa
Orion Engineered Carbons GmbH
Rodenbacher Chaussee 4
63457 Hanau-Wolfgang
Germany

phone +49 6181 59-6052
fax +49 6181 59-4096
at-ink@orioncarbons.com

Asia / Pacific
Orion Engineered Carbons Co., Ltd.
Technology Center
94 Galsan 1 -Dong, Bupyeong-gu
Incheon 403-081, Korea

phone +82 32 510 6075
fax +82 32 527 6023
at-ink@orioncarbons.com

www.orioncarbons.com

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