

# Carbon blacks with low amount of Polycyclic Aromatic Hydrocarbons (PAHs)

Technical Information 1483





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## List of abbreviations

HCF	High color furnace	FCM	Food contact material
MCF	Medium color furnace	ppm	parts per million
RCF	Regular color furnace	ppb	parts per billion
PAH	Polycyclic Aromatic Hydrocarbon	b.w.	by weight

# 1 Introduction

Stricter regulations, quality seals and increasing requirements on raw material purities have led to the closer look on possible dangerous substances in products used in plastics applications. Thereby, Polycyclic Aromatic Hydrocarbons (PAHs) have been identified as possible dangerous substances, resulting in the essential requirement to be eliminated at best in raw materials. Orion Engineered Carbons focuses on the development of safer products, in

particular on those, which are related to food- and skin-contact, to support the manufacturing of safe goods. The increasing knowledge on those substances together with the improvements of the analytical methods generate a detailed understanding. This brochure will present the findings by clarifying the different PAH regulations on your individual application needs.

## 2 PAH relevant regulations

As a result of the manufacturing process trace quantities of PAHs are present in carbon blacks. These contaminants are tightly bound to the surface of manufactured carbon black and can only be removed after vigorous solvent extraction in the laboratory.

### 2.1 Relevant regulations for plastics directly related to the raw material

#### 2.1.1 Commission Regulation (EU) No. 10/2011 (European Food Contact Regulation)

“Carbon black”, FCM\*-substance No. 411, Ref. No. 42080 is listed as an additive in Annex I “Union list” of Commission Regulation (EU) No. 10/2011 on plastic materials and articles intended to come into contact with food. This regulation and its amendments are commonly named as Plastics Implementing Measure (PIM) and include the following specification:

- Primary particles of 10 - 300 nm, which are aggregated to a size of 100 - 1200 nm possibly forming agglomerates within the size distribution of 300 nm – mm
- Toluene extractables: maximum 0.1 %, determined according to ISO method 6209
- UV absorption of Cyclohexane extract at 386 nm: < 0.02 AU for a 1 cm cell or < 0.1 AU for a 5 cm cell, determined according to a generally recognized method of analysis
- Benzo(a)pyrene content: maximum 0.25 mg / kg carbon black [0.25 ppm]

The Benzo(a)pyrene content is the most critical parameter to carbon black and there is no monitoring method defined by the EU Commission. Orion Engineered Carbons uses GC-MS (gas chromatography with mass spectrometry) of a hot extract with toluene according to an established FDA procedure.

The following restriction applies to FCM-substance No. 411; Ref. No. 42080.

- Maximum use level of carbon black in polymers: 2.5 % by weight



#### 2.1.2 Swiss Ordinance 817.023.21

The Swiss Federal Department of Home Affairs (FDHA) issued a revised version of the Ordinance of Materials and Articles (SR 817.023.21), which came into force on 1st May 2017. Article 35 of this section details the requirement that only permitted substances should be used in the manufacturing of packaging inks.

The restrictions and specifications of substance No. 1194 & EC Ref. No. 42080 “carbon black” are laid down in Annex 2 (plastics), Annex 9 (silicones) and Annex 10 (packaging inks).

The specification in regard to primary particles, toluene extractables, UV absorption of Cyclohexane and Benzo(a)pyrene content is identical with Commission Regulation (EU 10/2011). The carbon black content is limited for polymers with max. 2,5 % but no limitation of carbon black content for packaging inks.

### 2.1.3 French AVIS Séance du 07.11.1995 (encres et vernis pour l'impression des emballages)

Beside other restrictions the specification for "carbon black" is as follows:

- Toluene extractables: maximum 0.15 %
- Benzo(a)pyrene content:  $\leq 30 \mu\text{g/g}$  carbon black [0.03 ppm]

This regulation is one of the strictest and a lot of Orion Engineered Carbons' products meet these requirements.

### 2.1.4 FDA - 21 CFR Section 178.3297; colorants for polymers

According to this regulation the use of channel black (channel process, prepared by the impingement process from stripped natural gas) is allowed without any requirement on purity as a colorant for food contact related plastic applications. As this production process is not commonly used any longer, the FDA also allowed the use of furnace blacks in 1994, but with high requirements on purity as follows:

High purity furnace black (CAS 1333-86-4):

The amount of the PAHs listed in figure 1 must not exceed a total amount of 0.5 ppm; the amount of Benzo(a)pyrene must not exceed 5 ppb.



**Table 1**

**Amount of PAHs**

Naphthalene	Chrysene
Acenaphthylene	Benzo(b)fluoranthene
Acenaphthene	Benzo(k)fluoranthene
Fluorene	Benzo(e)pyrene
Phenanthrene	Benzo(a)pyrene
Anthracene	Perylene
Fluoranthene	Dibenzo(ac/ah)anthracene
Pyrene	Benzo(g,h,i)perylene
Benzo(g,h,i)fluoranthene	Indeno(1,2,3-cd)pyrene
Benzo(a)anthracene	Anthanthrene
Cyclopenta(c,d)pyrene	Coronene

Tests need to be conducted in accordance to FDA test method No. 63. Maximum use level of carbon black in the polymers: 2.5 % by weight



**Table 2**

**Specialty carbon blacks recommended for food-contact-related applications**

	EU member states	Switzerland	France	USA	Australia	Mercosur member states		Brazil		China	Japan
	Commission Regulation (EU) No. 10/2011; Resolution AP (89)	Swiss Ordinance 817.023.21	AVIS Séance du 07.11.1995	FDA - 21 CFR Section 178.3297	Australian Standard 2070-1999	Mercosur/GMC/RES. N° 32/07	Mercosur/GMC/RES. N° 15/10	ANVISA Consulta Pública n° 75, de 14 de agosto de 2007	ANVISA Resolucao - RDC n° 52, de 26 de novembro de 2010	National Standard of the People's Republic of China GB9685-2016	JHOSPA
<b>Europe</b>											
PRINTEX® 3 PWD <sup>2)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 25 PWD <sup>2)</sup>	●	●	○	○	●	●	●	●	●	●	○
PRINTEX® 30 <sup>2)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 35	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 45 PWD <sup>2)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 60 <sup>2)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 60 A <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 75	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 80	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 85	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 90	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® 95 <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® alpha A <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® alpha <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® F alpha <sup>1)</sup>	●	●	●	●	●	●	●	●	●	●	●
PRINTEX® F P <sup>1)</sup>	●	●	●	●	●	●	●	●	●	●	●
PRINTEX® F 80	●	●	●	●	●	●	●	●	●	●	●
PRINTEX® F 85 <sup>1)</sup>	●	●	●	●	●	●	●	●	●	●	●
PRINTEX® L	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® L6	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® L6 SQ <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® Nature	●	●	●	○	●	○	○	●	●	●	○
PRINTEX® P <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
PRINTEX® zeta A <sup>1)</sup>	●	●	●	○	●	●	●	●	●	●	●
LAMP BLACK 101	●	●	●	○	●	●	●	●	●	●	●
SPECIAL BLACK 250	●	●	○	○	●	●	●	●	●	●	○
SPECIAL BLACK 275	●	●	●	○	●	●	●	●	●	●	○
SPECIAL BLACK 350	●	●	●	○	●	●	●	●	●	●	●
SPECIAL BLACK 535	●	●	●	○	●	●	●	●	●	●	○
SPECIAL BLACK 550	●	●	●	○	●	●	●	●	●	●	○
<b>Korea</b>											
HIBLACK® 600L	●	●	●	○	●	●	●	●	●	●	●
HIBLACK® F890B	●	●	●	●	●	●	●	●	●	●	○
NEROX® 555	●	●	○	○	●	●	●	●	●	●	○
NEROX® 2500	●	●	○	○	●	●	●	●	●	●	○
NEROX® 3500	●	●	●	○	●	●	●	●	●	●	○

● Compliant with the purity criteria of the carbon black  
○ Not compliant

<sup>1)</sup> only beads available  
<sup>2)</sup> only powder available

## 2.2 Relevant regulations for plastics directly related to the final product

### 2.2.1 Commission Regulation (EU) No. 1272/2013

The following listed PAHs are referring to the Commission Regulation (EU) No. 1272/2013 of 6 December 2013 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). The required limits (e.g. on PAH), according to some voluntary quality standards, apply to the final consumer article, which may contain amongst others, only a small amount of specialty carbon blacks.

Orion Engineered Carbons points out, that those standards require tests on the final product, which are in the responsibility of the producer of the final product.

Articles made of rubber or plastic components coming into direct, prolonged or short-term repetitive contact with the human skin or the oral cavity, under normal or reasonably foreseeable conditions of use, must not contain more than 1 mg/kg b.w. of any of the listed PAHs.

In toys, including activity toys and childcare articles, the amount of any listed PAHs need to be below 0.5 mg/kg.

A specific testing method for the PAH's is not provided in this regulation. In many cases rubber or plastic manufacturers apply the AfPS GS 2014:01 test method, used for GS-Mark certification.

The method according to AfPS GS 2014:01, developed for plastic and rubber parts, cannot be used for carbon black. Suitable and valid test methods for the measurement of PAH's in carbon blacks are provided by the FDA method No. 63 and the ASTM D7771 (only for Benzo(a)pyrene).

**Table 3**

**PAHs set by Commission Regulation (EU) No. 1272/2013**

Substance	CAS-No.
Benzo(a)anthracene	56-55-3
Chrysene	218-01-9
Benzo(b)fluoranthene	205-99-2
Benzo(j)fluoranthene	205-82-3
Benzo(k)fluoranthene	207-08-8
Benzo(e)pyrene	192-97-2
Benzo(a)pyrene	50-32-8
Dibenzo(a,h)anthracene	53-70-3



### 2.2.2 GS-Mark

The German GS-Mark differentiates in 3 categories:

**Table 4**

**Limits for PAHs in ppm (mg/kg)**

Parameter	Category 1	Category 2		Category 3	
	Materials intended to be put in the mouth, or materials of toys with intended to long-term skin contact (longer than 30 seconds)	Materials not covered by category 1, with foreseeable skin contact for longer than 30 seconds (long-term skin contact) or repeated short-term skin contact		Materials not covered by category 1 or 2 with foreseeable skin contact up to 30 seconds (short term skin contact)	
		Toys in the scope of 2009/48/EC	Other products in the scope	Toys in the scope of 2009/84/EC	Other products in the scope
Benzo(a)pyrene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(e)pyrene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(a)anthracene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(b)fluoranthene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(j)fluoranthene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(k)fluoranthene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Chrysene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Dibenzo(a,h)anthracene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Benzo(g,h,i)perylene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Indeno(1,2,3-cd)pyrene	< 0.2	< 0.2	< 0.5	< 0.5	< 1
Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Pyrene, Anthracene, Fluoranthene	< 1 Sum	< 5 Sum	< 10 Sum	< 20 Sum	< 50 Sum
Naphthalene	< 1	< 2		< 10	
Sum of 18 PAH	< 1	< 5	< 10	< 20	< 50

**These limits are related to the final product. A migration test has to be passed according to the standard AfPS GS 2014:01.**

The data provided in our product safety information can be used to calculate the maximum possible potential of emerging PAHs caused by the PAH content.

Other ingredients, such as oils or plasticizers can also be potential PAH carriers.





### 2.2.3 OEKO-TEX® Standard 100

The OEKO-TEX® Standard 100 already existed before Commission Regulation (EU) No. 1272/2013 was brought into action, but was adapted based on this regulation.

The PAH limits of OEKO-TEX® Standard 100 (Status 2019) are as follows:

**Table 5**

**Limits for PAHs in ppm (mg/kg)**

Product class	I	II + III + IV
	Baby	II - In direct contact with skin III - With no direct contact with skin IV - Decoration material
Benzo(a)pyrene	< 0.5	< 1
Benzo(e)pyrene	< 0.5	< 1
Benzo(a)anthracene	< 0.5	< 1
Benzo(b)fluoranthene	< 0.5	< 1
Benzo(j)fluoranthene	< 0.5	< 1
Benzo(k)fluoranthene	< 0.5	< 1
Chrysene	< 0.5	< 1
Dibenzo(a,h)anthracene	< 0.5	< 1
Naphthalene	< 2.0	< 2.0
Sum of 24 PAH	< 5	< 10

The following table points out in detail the 24 PAHs of the aboved-mentioned "sum of 24 PAH".

The eight PAHs, stated in the first table, are although part of the sum of 24 PAHs.

**Table 6**

**Table of the single PAH's relevant for the sum of 24 PAH's.**

Substance	CAS-No.
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Anthracene	120-12-7
Benzo(a)anthracene	56-55-3
Benzo(a)pyrene	50-32-8
Benzo(b)fluoranthene	205-99-2
Benzo(e)pyrene	192-97-2
Benzo(g,h,i)perylene	191-24-2
Benzo(j)fluoranthene	205-82-3
Benzo(k)fluoranthene	207-08-9
Chrysene	218-01-9
Cyclopenta(c,d)pyrene	27208-37-3

Substance	CAS-No.
Dibenzo(a,h)anthracene	53-70-3
Dibenzo(a,e)pyrene	192-65-4
Dibenzo(a,h)pyrene	189-64-0
Dibenzo(a,i)pyrene	189-55-9
Dibenzo(a,l)pyrene	191-30-0
Fluoranthene	206-44-0
Fluorene/ Fluoren	86-73-7
Indeno(1,2,3-cd)pyrene	193-39-5
1-Methylpyrene	2381-21-7
Naphthalene	91-20-3
Phenanthrene	85-01-8
Pyrene	129-00-0



### 3 Product safety information

Orion Engineered Carbons provides individual product safety information for each of our products with detailed information on PAH content, registration status and food contact compliance in different regions.

The following is an example for the product PRINTEX® zeta A:

**Table 7**

**PAHs according to Commission Regulation (EU) No. 1272/2013<sup>a)</sup> and PAH-list AfPS-GS-2014-01<sup>c)</sup>**

Substance	CAS-No. [mPas]	ppm [mg/kg]	according to	
Benzo(a)anthracene	56-55-3	< 1	(EU) No 1272/2013 <sup>a)</sup>	PAH-list AfPS-GS-2014-01 <sup>c)</sup>
Chrysene	218-01-9	< 1		
Benzo(b)fluoranthene	205-99-2	< 1		
Benzo(j)fluoranthene	205-82-3	< 1		
Benzo(k)fluoranthene	207-08-8	< 1		
Benzo(e)pyrene	192-97-2	< 1		
Benzo(a)pyrene	50-32-8	< 0.03 <sup>b)</sup>		
Dibenzo(a,h)anthracene	53-70-2	< 1		
Benzo(g,h,i)perylene	191-24-2	< 1	Sum < 10	
Indeno(1,2,3-cd)pyrene	193-39-5	< 1		
Acenaphthylene	208-96-8			
Acenaphthene	83-32-9			
Fluorene	86-73-7			
Phenanthrene	85-01-8			
Pyrene	129-00-0			
Anthracene	120-12-7			
Fluoranthene	206-44-0			
Naphthalene	91-20-3	< 2.5		
Total of 18 PAHs (according) to PAH-list of AfPS-GS-2014-01 for GS-Mark certification)		< 10		

<sup>a)</sup> Referring to the PAHs as listed in Commission Regulation (EU) No. 1272/2013 of 6 December 2013 amending Annex XVII to Regulation (EC) No. 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards Polycyclic Aromatic Hydrocarbons.

Please note that the analytical investigation of PAHs is not part of our standard quality and production control. The following values are derived from random tests of single samples. Tests were conducted in accordance to FDA test method No. 63. The values are given for informational purposes only in order to enable you to do an overall assessment on substance concentrations in your final product and should not be considered as guaranteed specifications. Our general disclaimer below applies.

<sup>b)</sup> PRINTEX® zeta A BEADS is in compliance with French AVIS Séance du 07.11.195 (Encres et vernis pour l'impression des emballages).

<sup>c)</sup> Information in regards to GS-Mark: Total of 18 PAHs (according to PAH-List AfPS-GS-2014-01 for GS-Mark certification).

Based on this data it is possible to calculate the pigment loading and the PAH content of the final product, caused by carbon black.

The following example for the requirements fulfillment of GS-Mark category 1 with PRINTEX® zeta A shall clarify the above-mentioned approach:

At first the critical parameters for the GS-Mark category 1 have to be examined. The value of a single PAH or the sum of a group of several PAHs must not exceed the defined limits.

In case to meet the category 1 GS-Mark requirements by using PRINTEX® zeta A, the group of the 7 cited PAHs and Naphthalene must be below 1 ppm in the final product, while all other single PAHs have to stay below <0.2 ppm. Additionally, the total of 18 PAHs must be below 1 ppm in the final product. The maximum of 10 ppm on PRINTEX® zeta A would allow a maximum loading of 10% carbon black.

If you like to know more about the product safety status of our products or similar named grades with origin from outside Europe, please contact us. We appreciate to answer your individual questions.





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