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carbon black

43,000 metric tons per year

Carbon black is one of the darkest and most finely divided materials known. Chemically, carbon black is a colloidal form of elemental carbon consisting of 95 to 99 percent carbon.

As Carbon Black is typically rated based on ASTM (American Society for Testing and Materials) International standards or similar specialty standards understanding where TEfW Carbon Black fits in to the market is important. The particle size, structure, and surface area of carbon black plays a significant role in the material properties of rubber, plastics, and other products. For this reason, carbon black is made in various grades to meet the varying material needs and specifications of manufacturers. In general, carbon black grades with smaller particle size have better reinforcing and abrasion resistance qualities than those with larger particle size.

Figure 1: Carbon Black Particle Size Comparison

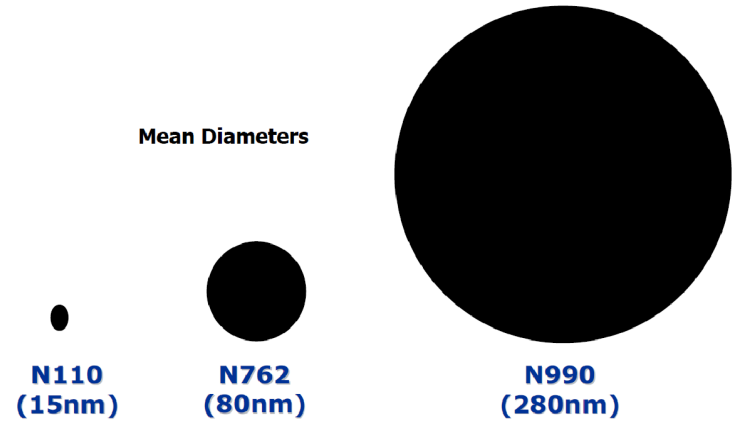
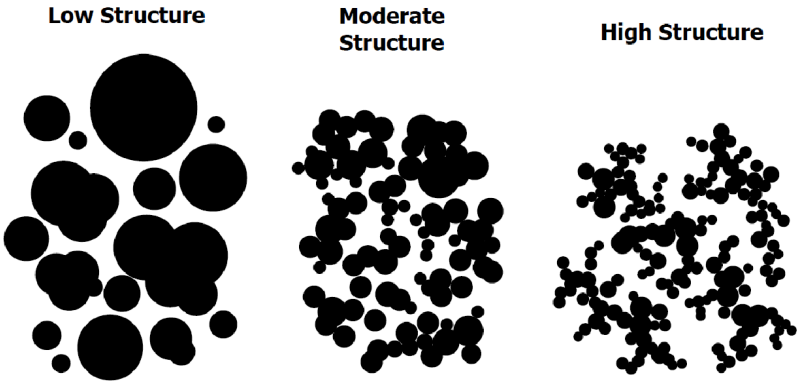


Figure 2: Carbon Black Structure Comparison



Traditionally Carbon Black is produced in a furnace black process. In the furnace black process aromatic oils (based on crude oil) are cracked under high temperature in a reactor, producing carbon black and tailgas. After cooling, the carbon black is separated from the tailgas, densified, and processed into pellets of varying grades/sizes. The cost of producing TEfW Carbon Black is substantially less and the product is green in comparison to the industry because its feed stock is free or “paid to take” waste versus purchased crude oil.

The finer the waste stream going into the system the finer the carbon black coming out of the third reactor. In the ZEWOP the waste stream is pre-processed to 2 mm in size. We beleive we can produce Carbon Blacks between ASTM 100 to 300, (eg N110, N134, N220) and potentialy specialty products blended with silicon and polymers.

APPENDIX One – Industrial uses for recycled Carbon Black

Industry	Application
Aerogel	Colorant Conductivity Enhancer
Adhesives & Sealants	Colorant Hardener Wear Extender Thixotropic Agent
Aerospace	High-Energy Particle Shielding Heat Dissipation High-Strength Laminates
Agriculture	Soil Amendment
Automotive	Tires High Temperature Gaskets Rubber Hoses Rubber Seals Carbon-Reinforced Body Parts
Ballistics	Shell/Missile Electronics EMP/RFI Shielding
Batteries & Power Storage	Carbon-Zinc Batteries Carbon/Air Fuel Cells
Bio-technology	Prosthetics Pharmaceutical Carriers Vascular Stents
Building Products	High-Strength Cables High-Strength Laminates Structural Composites
Cable	Transmission Line Cables Spark Plug Wires High-Voltage Carriers
Cable - Jacketing	High-Frequency Data Shielding
Cable - Semiconductor	Anisotropic Thermal Conduits
Chemical Catalyst	Catalyst Support/Carrier
Chemical Processing	Aromatic Solvent Precursor Absorbent Carbonation Agent
Coatings	Anti-fouling Coatings EMI/RFI Coatings
Composites	Concrete Hardener Additive Carbon Fibre Laminate
Cryogenic	Magneto thermal Shielding
Defence	Radar-Absorbing Coatings EMP Shielding Stealth Technology Body Armour Vehicle Armour

Electronics	Resistors Capacitors Molecular Electronics
Electrostatic Discharge (ESD)	Conductive Foam Conductive Plastics
Energy	Carbon-Oxygen Fuel Cell Carbon-Zinc Battery
Explosives	Gunpowder Black Powder Fireworks
Fibre	Carbon Fibre Composites
Film	EMI/RFI Shielding Films
Food	Colorant Absorbent
Fullerenes	Buckyballs Buckytubes Buckyropes
Industrial Process	Chemistry Metallurgy
Industrial Rubber Products	Gaskets O-rings Seals Tubes Sheets Hardener Wear Extender
Inkjet Colorants	Inks
Insulation	Thermal Transfer Layer RFI/EMI Shielding
Leather/Textiles	Carbon Fibre Materials Leather Colorant
Lighting	Arc Lamps Flat Panel Displays Cold Cathode Lighting Source

Magnetic Media	Field Emitters
Magnetic Resonance Imaging	Magnetic Field Directors Magnetic Field Imagers
Medical	Toxin Absorbent X-ray Imaging Dye
Mould Flux Powders	Thermal Transfer Media
Moulding	Mould Release Compound Antistatic Additive
Oilfield Drilling & Completion Fluids	Cutting Fluid Additive
Organic Synthesis	Carbonating Additive Colorant
Paper	Anti-static Coating Colorant
Personal Care	Cosmetics Air Filtration Water Filtration
Pharmaceuticals	Colorant Absorbent
Pipe	Steel Pipe Hardener Carbon-Reinforced Plastic Pipe
Pollution Abatement	Air Pollutant Adsorbent Water Pollutant Adsorbent
Printing Inks	Black Ink
Sheet	Gasket Products Carbon-reinforced Fibre Products
Silicones	Anti-wear Additive
Specialty Glasses & Ceramics	Colorant Thermal Conductivity Additive EMI/RFI Shielding Additive

Tire	Rubber Additive Hardener Wear Extender
Toners	Copier Toner Media Laser Printer Toner Media

APPENDIX Two -Carbon Black Pricing Sid Richardson Carbon & Energy

List Prices
Effective July 1, 2013

ASTM Grades - Ex-Works Prices

Grade	Shipping Point*	Bulk/Lb. Price	Grade	Shipping Point*	Bulk/Lb.Price
N110	G	$1.8475	N339	A,B,G	$1.5225
N115	G	$1.7750	N347	A	$1.5225
N120	B	$1.9900	N351	B	$1.4275
N121	A,G	$1.8725	N358	G	$1.4390
N134	B	$2.1175	N550	A,G	$1.3020
N220	B, G	$1.5500	N650	A,G	$1.2820
N231	B	$1.6070	N660	A,G	$1.2795
N234	A,B	$1.7400	N762	A,G	$1.2795
N299	A,B,G	$1.5360	N772	A,G	$1.2795
N326	A,G	$1.4275	N774	G	$1.2795
N330	A,B,G	$1.4275			

Specialty Blacks - Ex-Works Prices

Grade	Shipping Point*	Bulk/Lb. Price	Grade	Shipping Point*	Bulk/Lb. Price
SR123	G	$2.0475	SR401	G	$1.5390

SR129	A	$2.0264	SR511	G	$1.5020
SR155	A	$2.2175	SR530	G	$1.4020
SR201	A	$1.9500	SR611	G	$1.4820
SR301	G	$1.5275	SR630	G	$1.3820
SR303	G	$1.5275	SR699	G	$1.4295
SR310	B,G	$1.4325	SR711	G	$1.4795
SR315	B	$1.5275	SR750	G	1.3795
SR385	A	$1.8225	ES200	A	$2.8400

SidCon Blacks - Ex-Works Prices

Grade	Shipping Point*	Bulk/Lb. Price
SC119	G	$2.1475
SC159	A	$2.2175
SC419	G	$1.7390

*A = Addis, LA B = Big Spring, TX G = Borger, TX

Terms and Conditions

- The above prices are subject to SRCE's standard ters of sale (available for review at www.sidrich.com).
- SRCE reserves the right to charge a late fee of 1.5 percent per month on total overdue amounts.
- Constructively placed hopper cars held for more than 30 days are subject to a $50 per day demurrage charge.
- Payment Terms: net 30 Days.
- Minimum lead time is fourteen (14) business days.
- Prices are subject to change without notice.
- Restocking Fee: $500 minimum plus 5 percent value of product and freight.

Standard Packaging and Premium Charges

$0.0400 per pound for intermediate bulk containers above 60 cu. ft. (J, K, N)
$0.0500 Per pound for 60 cu. ft. intermediate bulk containers and below (R)
$0.0600 Per pound for 38 cu. ft. intermediate bulk containers with liner (L).
$0.0500 Per pound for paper bags. Available in 50 lb paper (A) or 25 KG (C)
$0.0500 Per pound for poly bags. Available in 50 lb poly (O) or 25 KG (O-1).
$0.0800 Per pound for 50-pound cardboard cartons.
$0.1000 Per pound for bag price for warehouse shipments.
$0.0200 Per pound for cardboard telescopic cartons on LTL shipments.

$0.0150 Per pound for hopper cars.
$40.00 per plastic pallet charge.
Purchases less than a full skid carry a $50.00 per invoice upcharge.

*Sid Richardson Carbon Co.'s poly bags have a specification vicat softening point of 94°C and a melt
point of 109°C. The end user assumes responsibility for determining if the bag is suitable for batch
inclusive applications.

Transloading Charges

$0.0200 Per pound from hopper car to hopper truck.
$0.0300 Per pound from hopper car to intermediate bulk container.
$0.0300 Per pound from hopper truck to intermediate bulk container.
$0.0300 Per pound from intermediate bulk container hopper car.
$0.0300 Per pound from intermediate bulk container to hopper truck.
$0.0600 Per pound from hopper car to intermediate bulk container to hopper truck.

Appendix 3- Chemical & Pysical Properties

Chemical and physical properties of carbon black										
Grade	**ASTM test**	**N-220**	**N-234**	**N-326**	**N-330**	**N-339**	**N-375**	**N-539**	**N-550**	**N-660**
Iodine adsorp. No, g/kg	D 1510	121ą5	120ą5	82ą5	82ą5	90ą5	90ą5	43ą5	43ą5	36ą5
DBP No, ml/100g	D 2424	114ą5	125ą5	72ą5	102ą5	120ą5	1114ą5	111ą5	121ą5	90ą5
CTAB absorp. m2/kg	D 3765	111ą5	119ą5	83ą5	82ą5	93ą5	96ą5	41ą5	42ą5	36ą5
Heating loss at 125 °C	D 1509	1,0 max	1,0 max	1,0 max	1,0 max	1,0 max	1,0 max	1,0 max	1,0 max	1,0 max
Ash content %	D 1506	max 1,0	max 1,0	max 1,0	max 1,0	max 1,0	max 1,0	max 1,0	max 1,0	max 1,0
Sieve resiude N 35%	D 1514	0,001 max	0,001 max	0,001 max	0,001 max	0,001 max	0,001 max	0,001 max	0,001 max	0,001 max
Sieve resiude N 325%		0,10 max	0,10 max	0,10 max	0,10 max	0,10 max	0,10 max	0,10 max	0,10 max	0,10 max

Fine Content %	D 1508	max 7	max 7	max 6	max 7	max 7	max 7	max 7	max 7	max 7
pour density kg/m3	D 1513	345ą30	320ą30	465ą30	375ą30	345ą30	345ą30	385ą30	360ą30	425ą30
Sulphur content %	D 1619	1,1 max	1,1 max	1,1 max	1,1 max	1,1 max	1,1 max	1,1 max	1,1 max	1,1 max
Colour strength %	D 3265	115ą5	124ą5	112ą5	103ą5	110ą5	115ą5	-	-	-
DBP No, after pressing ml/100g	D 3493	100ą5	103ą5	-	88ą5	101ą5	97ą5	84ą5	88ą5	75ą5
pH value	D 1512	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10	7-10
Toluol extract%	D 1618	90 min	90 min	90 min	85 min	75 min	75 min	80 min	80 min	75 min
Pellet hardness g	D 3303	15-100	15-100	15-100	15-100	15-100	15-100	15-100	15-100	15-100

Grade	Description / Uses
N-234	Fine active carbon black with increased structure. Provides high wear resistance and high level of reinforcement of different rubbers. Rubbers, containing N-234, are characterized by high modulus and good smoth extrusion of raw compound. Car tyre treads with high performance, retreading. High quality industrial rubber goods and conveyor belts.
N-220	Fine active carbon black. Imparts to rubber high wear resistance and tear strength, relatively low modulus. Tyre tread, retreading. High-quality industrial rubber goods and high grade conveyor belts.
N-375	Fine active carbon black. Provide high breaking and wear resistance. Improved ability of process. Tyre treads, retreading. Industrial rubber goods and conveyor belts.
N-339	Fine active carbon black with increased strucure. Imparts high modulus, improved extrusion, wear resistance and hysteresis N-330. Tyre treads, retreading. Industrial rubber goods and conveyor belts.
N-330	Fine active carbon black. Provides high stensile strength and good wear resistance. Tyre breaker and sidewalls. Solid tyres, agrucultural tyres, sleeve, conveyor belts, industrial rubber goods, fan-belt.
N-326	Fine low-structure active carbon black. Gives low modulus, high elongation at break, high tear and fatigue strength. Compundus for tyre breaker, including breaker for solid and off-road tyres.
N-550	Medium-dispersion, medium-active carbon black. Imparts high extrudability, relatively high tear resistance. Compounds for tyre carcass and tube. Profile-extruded goods. Industrial rubber good, seal, hoses.
N-539	Similar to N-550 it is medium-dispersion, medium-active carbon black. Provides improved processing properties, possible increased loading. Compounds for tyre carcass and tube. Profile-extruded goods. Industrial rubber good, seal, hoses. One-layer roofing system.

N-660	Medium-dispersion, medium-active, low-structure carbon black. Provides higher die-swell, high resilience at relatively high hardness. May be incorporated in large quantity. Compounds for tyre carcass and tube. Moulded goods, goods extrusion. Industrial rubber goods, sleeves. One-layer roofing system. Isolating cable rubbers.

Chemical and physical properties of carbon black						
Grade	**K-163**	**K-173**	**K-354**	**N-772**	**N-990**	**Test metode**
Iodine No, mg/g	-	-	80±5	22-34	5-15	ASTM D-1510
DBP absorption, cm3/100g	-	-	95-110	70-80 or 65±5	30-45 or 35±5	ASTM D-2414
pH of water suspension	-	-	3,7-4,7	9-11	7-11	ASTM D-1512
Fraction of total mass loss at 105 °C %, max	6	5	1,5	0,5	0,15	ASTM D-1509
Ash content, max%	0,2	0,1	0,05	0,5	0,15	ASTM D-1506
Fraction of total mass loss after screening through a mesh %, max						ASTM D-1506
35 mm	-	-	0,001	0,001	0,001	
325 mm	-	-	0,08	0,08	0,08	
Dush content , max%	-	-	6	7	8	ASTM D-1508
Bulk density, kg/m3, min	-	-	340	420	330	ASTM D-1513
Specific surface, mg2/g	min 190	min 230	90-100	33-39	12-16	GOST 7885-86
Average size of particles, mm	10-19	10-19	25-30	60-100	>200	Electron microscope

Grade	Description	Field of application	Uses
N-990	This is obtained by thermal decomposition of natural gas in batch furnaces without access for air. It belongs to low active grades of carbon black and is characterized by the most low values of specific surface and structure index in comparison with other grades. It is made inpellet or powder form.	For rubbers	Ensures excellent technological properties of rubber mixes while processing, possibility to attain a high degree of filling of polymeric composition thus used for manufacturer of conveyor belts, as inactive filler for tyres, industrial rubber goods with a high content of the filler.
		For carbon graphite materials	It graphitizes well. Along with the strenghtening effect it ensures a high conductivity of articles. It shows a low gas emission during heat treatment. It gives good technological properties to mixes.
N-772	It is obtained in a continuous process in the furnace by a thermal-oxidative decomposition of natural gas.	For rubbers	Good dynamic properties to rubbers with a relatively low dispersion are imparted by this grade of carbon black. It

	It belongs to semiactive grades of carbon black and it shows low values of dispersion and structural features. It is made in pellet form.		allows to obtain an optimum combination processing of mixes. It is used in manufacture of frameworks, extruding rubber articles, tube, rubber articles subject to dynamic loads. It is also used as a semiactive filler in production of the industrial rubber articles, it is used in masterbatch.
		For paintwork materials and for painting polymeric materials	It is used to give a black tint in the mix for printing ink, as a pigment for plastic materials, UV - stabilizer for polyolefins. This grade of carbon black is one of major components of masterbatch which is used for pigmenting.
K-354	This is obtained by a channel mode in a diffusive flame during a thermal-oxidatative decomposition of natural gas. It belongs to active graded of carbon black and it has a high dispersion value and a low structural value. It is a highly dispersive and enhancing filler and a pigment. It is made in pellet form.	For rubbers	Makes rubber mixes resistant to premature vulcanization. Makes vulcanizate and articles strong when static and dynamic loads are applied. It is used for production of extra strong industrial rubber goods.
		For paintwork materials, painting of polymeric materials and for perfumery	It disperses well and forms highly stable dispersions. It ensures an intensive black colour of materials, excellent apperance of coats, resistance of painting to the ultraviolet radiation. It is used for making intensively black varnishes and coast, synthetic fibres, printing ink, carbon paper, typewriter tapes, in perfumery for making the eyelash ink.
K-163 **K-173-0**	The pigment carbon black is obtained by the channel method by setting carbon black particles which are performed in the diffusion flame with an incomplete combustion of natural gas, on a metal surface with a further oxidation (K-173-0) or without oxidation. These belong to special highly black grades of the carbon black and they are characterized by a high dispersion value and a high content of volatiles.	For carbon graphite materials	This gives a good enhancing effect due to a high dispersion ability and an active surface. It is highly pure from the point of view of content of mineral admixtures.
		For paintwork materials, painting of polymeric materials and for perfumery	These are high quality ultra dispersing black pigments which ensure a high depth of black colour of the paintwork and impressions, resistance of the paint to the ultraviolet radiation, lustre of the nitrocellulose enamels for cars. These disperse well

			and highly stable dispersions are obtained as a result of this. They are used for making paints, varnishes, painting ink, rolling paste for printing arts, carbon paper for eyelash ink.