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# Carbon black: Production, properties, and utilization

**Mohamad Agus Ramly**[1], **Muji Setiyo**[2,3]

[1] PT. Dhiya Aneka Teknik, Serang 42115, **Indonesia**
[2] Department of Mechanical Engineering, Universitas Muhammadiyah Magelang, **Indonesia**
[3] Center of Energy for Society and Industry (CESI), Universitas Muhammadiyah Magelang, **Indonesia**
✉ mohamad.agus@gmail.com

## Abstract
As of today, only a few people know about carbon black. Their knowledge and understanding are also limited to the fact that carbon is charcoal from coconut shells or black activated carbon. In addition, some people only know carbon as carbon copy and ink material. On the other hand, there is another type of carbon that comes from oil content and can be used for various industrial purposes. This carbon is produced and used with advanced and modern technology, which is called carbon black. Currently, by looking at the market signal, carbon black has become a very profitable commodity. Carbon black industries develop systems and technologies to produce the best quality with minimized environmental effects. In fact, because of the promising price and high market demand, carbon black factories invest in advanced production equipment. In its development, through continuous research and by utilizing advances in industrial technology, currently, carbon black can be added to various materials to improve the physical, electrical, or optical properties of the material.

**Keywords:** Carbon black, Properties, Anti-static agent, Rubber product

## 1. What Is Carbon Black?

Carbon black has been used extensively to modify the mechanical, electrical, and other physical properties of the medium in which it is dispersed. These are the most widely used nanomaterials, with particle dimensions ranging from tens to several hundreds of nanometers (nms). It plays a major role in elastomers, plastics, paints and inks as a reinforcing agent, black pigment and electrically conductive material [1]. Carbon black is a black particles in the form of fine powder or granules containing more than 95% pure carbon which is produced in a highly controlled process to produce particles and aggregates of various structures and surface chemistries resulting in a range of products that offer a wide range of characteristics and advantages for their uses. Carbon black is produced from decant oil which is burned at high temperatures along with other auxiliary materials consisting of molasses and additives. Apart from decant oil, carbon black can also be produced from incomplete combustion of coal and coal tar, vegetable matter, liquid catalytic cracking tar, and ethylene cracking in a limited supply of air.

Compositionally, carbon black are composed of a single compound with the chemical name of carbon black or furnace black which has the chemical formula C with CAS number RN: 1333-86-4, EINECS/ELINCS Number: 215-609-9 and weight: >99%, with a degree of acidity at pH: 4 - 11 [50 g/l water, 68°F (20°C)] in the non-oxidized state, and pH: 2-4 in the oxidized state. Carbon black has a density between 1.7 - 1.9 g/cm$^3$ @ 20°C, with a bulk density of 65-520 kg/m$^3$ (granular), and 20-380 kg/m$^3$ (downy), and has a volatile (by weight) < 2.5% (950°C) in the non-oxidized state and 2-8% in the oxidized state [2].

Carbon black particles tend to join one particle with another to form aggregates that determine the class structure [3]. In general, various types of carbon black are made by the pyrolysis method of hydrocarbons, so both chemically and physically carbon black is different from graphite and diamond. Carbon black has a particle size of between 10 and 500 nm and a surface area of between 6 and 1200 m$^2$/gm. Carbon black is odorless and is most widely used as a filler in the rubber, plastic, ink, and coating industries. Depending on the production process, carbon black has differences in particle size, surface area, porosity, and other characteristics, which determine its grade. Using these parameters, very tight control is carried out in the production process, from the front end to the back end. Carbon black in granular form is presented in **Figure 1**.

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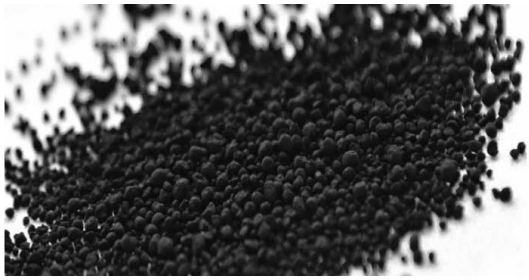

Carbon black is composed of elemental carbon in the form of semispherical, colloidal particles coalesced into each other to form particle aggregates.

It is obtained by thermal decomposition of highly aromatic hydrocarbon feedstock such as FCC Decant Oil, Hydro-treated RFCC Slurry Oil, Ethylene Tar Oil, Heavy oil from Coal Tar Oil.

**Figure 1.** Carbon black [2]

# 2. Utilization of Carbon Black

Carbon black is used in small-scale industries up to large-scale industries that affect national interests. In addition to rubber reinforcement, Carbon Black is used as a black pigment and as an additive to improve material performance, including conductivity, viscosity, static charge control and UV protection. This type of Carbon Black (commonly called Special Carbon Black) is used in a variety of applications in the coatings, polymer and printing industries, as well as in a variety of other specialty applications [4]. In general, the use of carbon black is presented in **Figure 2**.

## 2.1. Dyes for Inks and Paints

Carbon black is used as an excellent black coloring agent. Therefore, it is widely used for printing inks, resin dyes, paints and toners because it has better color strength compared to iron oxide or organic pigments. Carbon black with a larger structure shows excellent conductive properties.

## 2.2. Dyes for Plastics

Carbon black is suitable for coloring resins and plastic films because it has high color strength and is stable even at high temperatures.

## 2.3. Material for Car Bumpers, Cable Coatings, and Pipes

Due to its excellent nature of absorbing ultraviolet (UV) rays and providing better weather resistance, Carbon black is also used in the car bumper industry, wire coatings and pipe coatings.

## 2.4. Anti-static Agent

Carbon black is also used as an excellent antistatic agent, where the particles have a crystal structure that functions as a conductive filler in plastics, elastomers, paints, adhesives, and films. A certain type of carbon black, called special black or performance black, is used as a pigment to increase conductivity and control static charge, thereby providing UV protection and improving mechanical properties in products such as plastics, inks, paints and coatings, toners and electronics.


**Figure 2.** Utilization of carbon black (source: link)

## 2.5. Mixture of Rubber Products

The use of carbon black in the largest volume is for performance additive in rubber products, especially in tires and other rubber industrial goods such as hoses, belts, extrusion profiles, and molded rubber goods. Now, the use of carbon black has also penetrated into automotive rubber parts such as hoses, belts, gaskets, seals, wipers, and all rubber parts.

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Ir. H. Mohamad Agus Ramly, S.T., S.E., IPM has an educational background in Mechanical Engineering and Human Resource Management with experience working in various industries for more than 35 years. From 1986 to 1988 he worked at PT Astra Group, the automotive industry as a quality control staff. Continued to PT Asahimas Subentra Chemical, a petrochemical company in production ruled from 1988 to 1991. He also has experience in operation when he started joining PT Cabot Indonesia in November 1991 as a production supervisor. PT Cabot Indonesia is a carbon black producer affiliated with Cabot Corporation USA. Leaving PT Cabot Indonesia in 2013, he has experience of more than 7 years in another carbon black plant when he got responsible for a carbon black project and commissioning supervisor at Abu Dhabi National Oil Company (ADNOC) from 2013 up to the end of 2020. He also has lecturer experience from July 2006 to September 2010 at the Department of Mechanical Engineering, Universitas Sultan Ageng Tirtayasa (UNTIRTA), Banten for the Occupational Safety and Health Course (K3). He is also a lecturer for the "Program Praktisi Mengajar" created by the Minister of Culture and Educations Republic of Indonesia (KEMENDIKBUDRISTEK) and another activity as an assessor at the LAM TEKNIK, an independence Accreditation Body under the Indonesian Engineers Association. Currently, he is a trainer and instructor at PT. DHIYA ANEKA TEKNIK, an OHS Service Company (PJK3) for some training programs such as Permit to Work - RCA – HIRADC – SOP development and safety for supervisor program.

Muji Setiyo is a professor in Mechanical Engineering at the Universitas Muhammadiyah Magelang (Unimma). He obtained a Bachelor's degree from the Universitas Muhammadiyah Yogyakarta (2009), a Master of Engineering from Pancasila University (2012), and obtained a Doctoral Degree in Mechanical Engineering from Brawijaya University (2017), all in the field of Mechanical Engineering. In 2022, he graduated from the Engineer Professional Program at Universitas Muhammadiyah Yogyakarta. Apart from teaching and researching, currently, he is active as an Editor in Mechanical Engineering for Society and Industry (MESI) and Automotive Experiences, two scientific journals published by Universitas Muhammadiyah Magelang (Unimma).