

CONDUCTIVE COMPOUNDS



**CABOT**

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## CABELEC® Compounds Processing Guide



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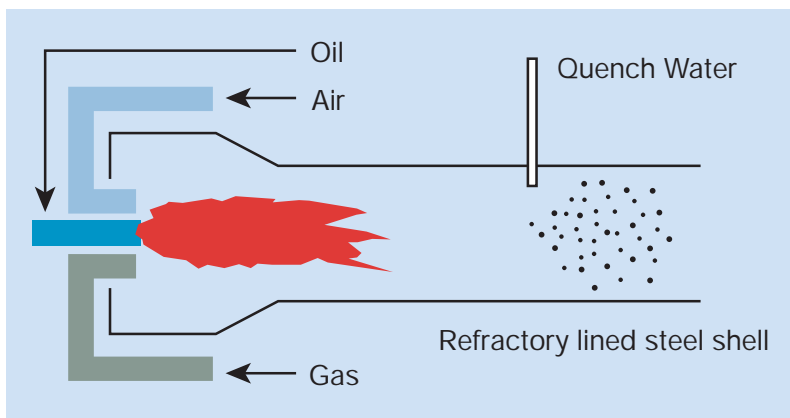
CABELEC compounds are a range of compounds that are electrically conductive thereby reducing the risk of electrostatic discharge. The conductive properties of the compounds are permanent. CABELEC compounds are based on a large variety of thermoplastic polymers and are designed to fulfil specific requirements related to electrical, rheological and mechanical properties. A range of CABELEC compounds is available for different processing techniques such as blown film extrusion, sheet and profile extrusion, injection moulding, blow moulding, etc.

## Conductive carbon black

CABELEC compounds are carefully formulated products based on conductive carbon black. The type of carbon black, the addition level and the dispersion quality are key factors for achieving good conductivity – or low electrical resistivity.

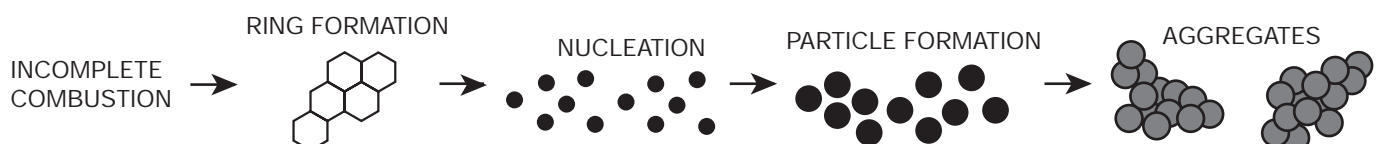
Carbon black is a particulate form of industrial carbon produced by thermal cracking or thermal decomposition of a hydrocarbon raw material. Many processes historically have been used to produce carbon black, but the most important now is the oil furnace process. It consists of atomising a heavy aromatic fraction of petroleum distillate into a preheated, closed furnace followed by cooling and collecting the formed carbon particles.

**Carbon Black Oil Furnace Process**



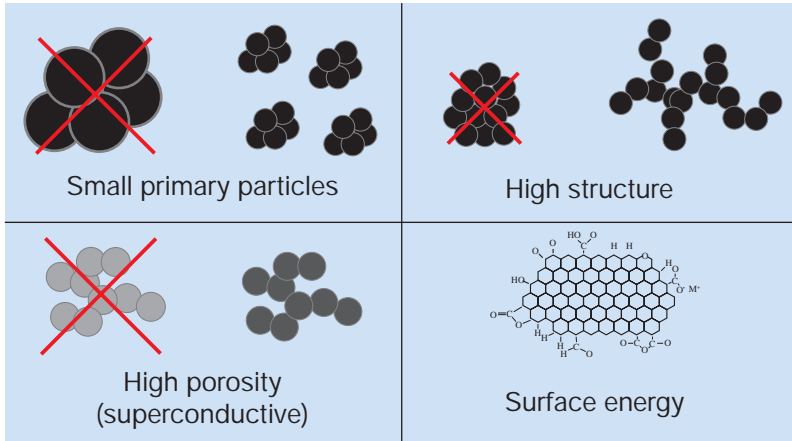
Electron microscopy inspection reveals that carbon black is composed of aggregates, which resemble fused clusters of spherical primary particles.

**Carbon black oil furnace process**



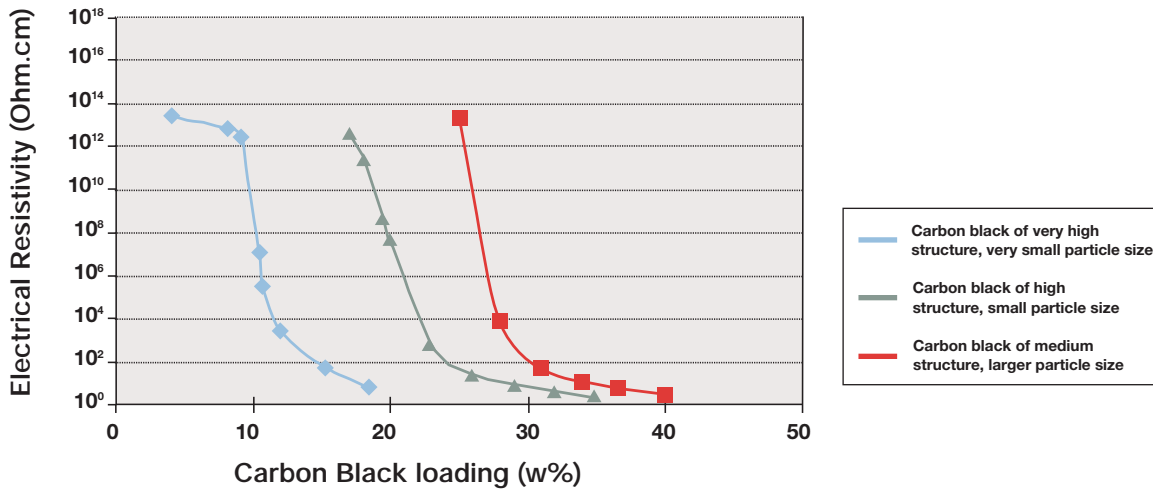
Both the aggregate size and shape, and the primary particle size, are controlling factors in determining carbon black performance. The following characteristics are key for a carbon black of good electrical conductivity:

### Carbon black structure & properties



The addition level of carbon black in the polymer must be sufficient so that the carbon black particles touch, or are less than 10 nm away from each other. The relationship between the quantity of carbon black added and the electrical resistivity achieved is shown in the percolation curves below.

### Examples of percolation curves



# Processing CABELEC compounds

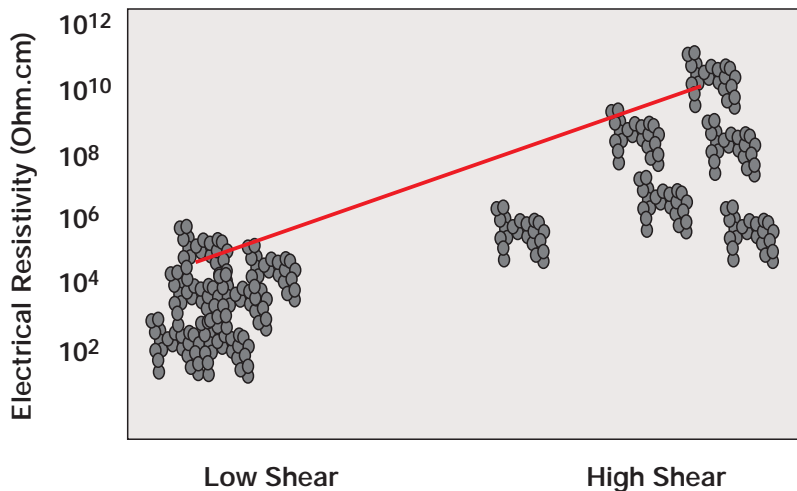
## Predrying

As the carbon black contained in the compounds is hygroscopic, CABELEC compounds should be stored in a dry place. Before processing – unless specified in the Product Data Sheet for the specific grade – the compounds need to be predried. Processing a compound having too high a moisture content will result in, for example, surface blemishes in the injection moulded part, holes in the blown film, and so on.

## Processing

CABELEC compounds can usually be processed on conventional processing equipment. To ensure good electrical and mechanical properties of the material, it is strongly recommended that the compounds be processed under low shear conditions. In fact, conductive carbon black filled compounds are highly shear sensitive. Too much shear deteriorates the carbon black structure and will result in higher electrical resistivity of the manufactured item.

**Influence of shear on carbon black structure and electrical resistivity**



Processing equipment and parameters should be carefully selected so that the shear generated is kept to a minimum. For more details please refer to the specific CABELEC processing sections.

## Dilution

CABELEC products provide optimum performance when used alone i.e. without dilution with non-conductive raw materials. For this reason we do not recommend dilution. In some processing techniques dilution is performed via addition of regrind. One should keep in mind the fact that the regrind is increasingly "diluted " resulting in progressively lower fractions of conductive material in the finished part. Appropriate blending and feeding procedures are required to maintain the desired resistivity levels. Rigorous testing of the electrical resistivity is also strongly recommended.

## Purging

After a CABELEC production run purging of the equipment is required. Due to its high carbon black content, CABELEC can be problematic when changing to a natural or light coloured material. It is generally recommended to purge with a natural, high viscosity resin and to clean the screw and barrel mechanically.

# Blow Moulding

## Applications



CABELEC conductive compounds are used in a variety of blow moulding applications ranging from large containers such as industrial bulk containers (IBC's), drums and jerry-cans to technical parts such as conductive automotive filler pipes. Many containers made of CABELEC compounds designed for the transportation of dangerous goods have successfully passed the UN test procedures and are listed as BAM approved packaging. When compared with natural polyethylene, conductive compounds show a higher sensitivity to shear, a faster cooling rate due to better thermal conductivity and a slightly higher viscosity. The most important parameters for the processing of CABELEC grades are summarised in the guidelines below.

## Equipment requirements for blow moulding of CABELEC compounds

CABELEC can be processed on most conventional continuous extrusion as well as accumulator head equipment. Screws with grooved feed zones and L/D ratios between 20 and 30 are recommended. Despite the shear sensitivity of conductive materials, usual shear- and mixing elements of HDPE screws are suitable provided a minimum of precautions are taken for the process conditions.

With appropriate grade selection, coextruded parts and containers can be successfully produced from CABELEC products.

Conventional moulds are generally suitable for the manufacture of CABELEC parts. General guidelines for natural polyolefins are still valid.



## Processing parameters

The main process parameters that should be considered are listed below with their corresponding guidelines/explanations :

Processing parameters	Comments/recommendations
Temperatures	Melt temperatures : typical range : 200-240°C Die lip temperature : typical range : 210-240°C A too low die lip temperature can affect resistivity even at higher melt temperatures. It can also generate variation in conductivity along the circumference of the parison
Piston or Ram speed	On accu-head lines the ram speed should be kept as low as possible due to the high shear rates generated during parison formation
Screw speed	Conventional screw speed levels for natural polymers can be used
Mould closing speed	As for natural HDPE the appropriate balance needs to be found to achieve good welding quality. An excessive speed (or too late transition point to reduced speed) can lead to an inappropriate weld geometry
Parison cooling/mould cooling	CABELEC compounds exhibit a far higher thermal conductivity than natural polymers. As a result parison cooling is faster. This leads to shorter cooling times but also needs to be taken into consideration for the welding line quality
Melt strength	Due to the carbon black network CABELEC products are characterised by high melt strength levels which help to reach a tight thickness distribution profile
Mould temperatures	As for natural polyethylene low mould temperatures are preferable to minimise cycle time (typical cooling water temperatures : 10-25°C)

## Troubleshooting guide

Problem	Potential cause	Recommendations
Rough surface	Melt temperature too low Die temperature too low Ram speed too high	Increase melt and die temperatures  Reduce ram speed
Flow marks/surface defects	Purge effect due to high viscosity of CABELEC	Complete purge of the equipment
Bubbles	Air entrapment, excessive moisture level	Vent the equipment, pre-dry material
Weld seam is too weak	Melt temperature is too low Extrusion/ram speed too low Mould closing speed inappropriate	Adjust melt temperatures Increase ram speed Adjust mould closing speed and change-over limits
Uneven appearance on mould surface	Insufficient or non homogeneous venting	Improve venting
Surface resistivity too high	Die lip temperature too low Melt temperature too low Excessive shear	Increase (significantly) die lip and melt temperature  Reduce ram/piston speed
Uneven resistivity levels	Uneven parison resistivity Uneven stretching/blow up ratios	Increase head/die temperatures Verify thickness distribution

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