C.F. NIELSEN

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RUF BRIQUETTING SYSTEMS

WHITE PAPER

CARBONIZATION TECHNOLOGY

THE PROCESS

Carbonization is a pyrolytic reaction and a complex process involving breakdown of different substances where many reactions - such as dehydrogenation, condensation, hydrogen transfer and isomerization - take place concurrently. Here we focus on the carbonization of wood.
The first step in carbonization is either to pre-dry the wood or dry out the wood in the kiln at 100C to zero moisture content.
During the second step the temperature is raised to 280-300C and the wood starts to break-down and produce charcoal.

During this initial process the energy comes from some of the wood charged to the kiln combined with oxygen and energy released from the carbonization process.
During the third step the temperature is raised to 400C using only energy from the carbonization process. To reach higher temperatures it might be necessary to add more heat, but this will depend on the type of wood, type of kiln and moisture of the material being carbonized.
With increasing temperatures, the amount of fixed carbon increases and the number of volatiles decreases. The following chart is an example of this:

Carbonization temperature	Chemical analysis of charcoal		Charcoal yield based on oven dry wood
C	% of fixed charcoal	% volatile material	0% moisture
300	68	31	42
500	86	13	33
700	92	7	30

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COMMERCIAL CHARCOAL

Good commercial charcoal should have a fixed carbon content of approx. 75%, but the quality also depends on the cycle time of the different temperature steps, and the ash and final moisture content. The ash content depends on the type of wood used. It is important to use a well-designed kiln to produce a consistent homogenous quality.
The quality of the charcoal also depends on the type of wood being carbonized. Generally mature wood, with high density, high lignin content is preferred and most of such qualities are generally found in some of the densest hardwoods.

THE ADVANTAGES

- Large metallurgical companies want to switch coal and coke as raw material to more sustainable raw materials such as bio coal and bio coke
- The consumer coal market requires higher quality and more sophisticated products
- The demand for char and activated carbon is increasing, as it can be used for many applications including carbon sequestration, oral care, skin care, air treatment, water treatment etc.
- Charcoal with a high carbon content has a high energy density, and with the right densification technology there can be a considerably reduction in energy costs.
- Using briquettes for carbonization can add additional advantages and can be see below.

The advantages using charcoal described in the following are based on semi-industrial or industrial processes with well-designed PLC operated kilns being used in combination with sustainable wood.

The market for charcoal is generally increasing due to the following drivers:

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C.F. NIELSEN AND CARBONIZATION

A couple of years ago C.F. Nielsen obtained firm interest from 2 customers asking C.F. Nielsen to co-operate with them to develop new charcoal products as follows:

- Bio coal and bio coke to replace coal and coke for the metallurgical industry
- Improved process technology for producing carbonized briquettes for the consumer and commercial market

C.F. Nielsen applied for an obtained a grant from the Danish Energy Ministry. The project has now been running for 3 years including the following main achievements:

- Acquisition of the Shimada Extrusion Briquetting Technology and developing a full process combined with carbonization
- Investment in a new test centre including chipping, milling, drying, briquetting and test carbonization equipment
- Continuous testing of different wood and agri-based raw materials obtaining higher carbon contents and higher strengths
- Sample production of bio coal and bio coke meeting international specifications

The project is continuing in close co-operation with customers.