

4C3. Briquette Production Technology

Technology Overview

1. Background

Global warming, caused by CO₂ and other substances, has become an international concern in recent years. To protect forestry resources, which act as major absorbers of CO₂, controlling the ever-increasing deforestation, along with the increase in the consumption of wood fuels, such as firewood and charcoal, is an urgent issue. Given this, the development of a

substitute fuel for charcoal is necessary. Briquette production technology, a type of clean coal technology, can help prevent flooding and serve as a global warming countermeasure by conserving forestry resources through the provision of a stable supply of briquettes as a substitute for charcoal and firewood.

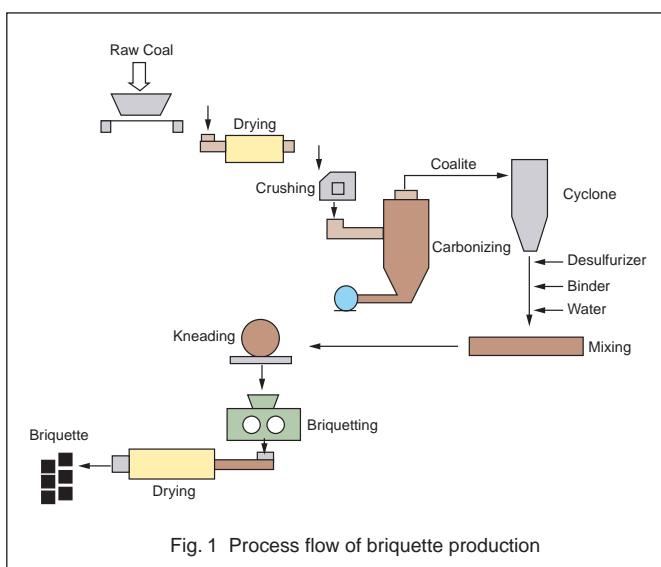
2. Carbonized briquettes

(1) Process overview

The coal briquette carbonization production process consists of a carbonization stage and a forming stage. Figure 1 shows the basic process flow.

In the carbonization stage, an internal-heating, low-temperature fluidized-bed carbonization furnace (approximately 450°C) produces smokeless semi-coke containing approximately 20% volatile matter. The carbonization furnace has a simple structure, with no perforated plates or agitator, making it easy to operate and maintain.

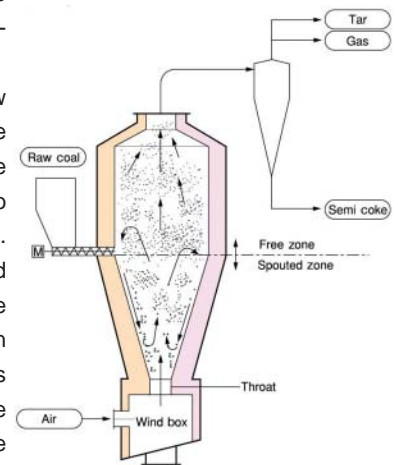
In the forming stage, the smokeless semi-coke and auxiliary raw materials, hydrated lime and clay, are thoroughly mixed at a predetermined mixing ratio. After pulverizing, the mixture is blended with a caking additive while water is added to adjust the water content of the mixture. The mixture is kneaded to uniformly distribute the caking additive, and to increase the viscosity in order to make the forming of the briquettes easy. The mixture is then introduced into the molding machine to prepare the briquettes. The briquettes are dried and cooled.



(2) Carbonization stage

The raw coal (10% or lower surface water content, 5-50mm particle size) is preliminarily dried in a rotary dryer. The gas exhausted from the dryer passes through a multi-cyclone to remove the dust before venting the gas to the atmosphere. Figure 2 shows a cross-sectional view of the internal-heating, low-temperature fluidized-bed carbonization furnace, the most efficient process for carbonizing semi-coke and one which retains approximately 20% of the volatile matter in the semi-coke.

The preliminarily dried raw coal is charged to the middle section of the furnace, and is subjected to fluidization carbonization. The semi-coke is discharged from the top of the furnace together with the carbonization gas. The semi-coke is separated from the carbonization gas by the primary cyclone and the secondary cyclone.



After cooled, the semi-coke

is transferred to a stockyard, and the carbonization gas is supplied to the refractory-lined combustion furnace, where the carbonization gas is mixed with air to combust. The generated hot gas is injected into the raw coal dryer and to the succeeding briquette dryer to use as the drying heat source for the preliminary heating of the raw coal and the drying heat source of the formed oval briquettes.

(3) Forming stage

The semi-coke (Coalite) produced in the carbonization stage is the raw material for the briquette, containing adequate amounts of volatile matter, little ash and sulfur, and emitting no smoke or odor. The semi-coke, as the primary raw material, is mixed with hydrated lime (sulfur fixing agent), clay (to assist forming), and a caking additive.

To attain uniform composition and improved formability, the blended raw materials are fully kneaded. The forming of the mixture is carried out using a roll-molding machine at normal temperatures and under approximately 1,000 kg/cm (300-500 kg/cm²) of line pressure. Photo 1 shows the forming state.

In the final stage, the formed briquettes are dried in the continuous dryer. Since semi-coke is used as a raw material for the briquettes, they are highly ignitable and can readily ignite in the furnace if the dryer is not operated at low temperatures. The dryer was designed with this temperature-sensitive concern in mind.



Photo 1 Formed briquettes

3. Bio-briquettes

Bio-briquettes are a type of solid fuel, prepared by blending coal with 10-25% biomass, such as wood, bagasse (fibrous residue of processed sugar cane stalks), straw, and corn stalks. A desulfurizing agent, Ca(OH)₂, is also added in an amount corresponding to the sulfur content of the coal. Owing to the high pressure briquetting (1-3 t/cm²), the coal particles and the fibrous biomass material in the bio-briquette strongly intertwine and adhere to each other. As a result, they do not separate from each other during combustion, and the low ignition temperature biomass simultaneously combusts with the coal. The combined combustion gives favorable ignition and fuel properties, emits little dust and soot, and generates sandy combustion ash, leaving no clinker. Furthermore, since the desulfurizing agent also adheres to the coal particles, the agent effectively reacts with the sulfur in the coal to fix about 60-80% of the sulfur into the ash. Many coal ranks can be used, including bituminous coal, sub-bituminous coal, and brown coal. In particular, the bio-briquettes produced with low grade coal containing large amounts of ash and having low calorific value combust cleanly, thus the bio-briquette technology is an effective technology to produce clean fuel for household heaters and small industrial boilers.

(1) Bio-briquette production process

Figure 3 shows the basics of the bio-briquette production process. The raw materials, coal and biomass, are pulverized to a size of approximately 3 mm or smaller, and then dried. The dried mixture is further blended with a desulfurizing agent, Ca(OH)₂. The mixture is formed by compression molding in a high-pressure briquetting machine. Powder coal may be utilized without being pulverized. A small amount of binder may be added to some coal ranks. The production process does not involve high temperatures, and is centered on a dry, high-pressure briquetting machine. The process has a simple flow, which is safe and which does not require skilled operating technique. Owing to the high-pressure briquetting process, the coal particles and the biomass strongly intertwine and adhere to each other, thus the process produces rigid formed coal, which does not separate during combustion.

(2) Bio-briquette characteristics

1. Bio-briquette combustion decreases the generation of dust and soot to one-fifth to one-tenth that of direct coal combustion. Direct coal combustion increases the generation of dust and soot because the volatile matter released at low temperatures (200-400°C) does not completely combust. To the contrary, bio-briquettes simultaneously combust the low ignition point biomass,

which permeates the coal particles, assuring the combustion of volatile matter at low combustion temperatures. As a result, the amount of generated dust and soot is significantly reduced.

2. Bio-briquettes prepared by blending biomass with coal have a significantly shorter ignition time. In addition, because of the low expansibility and caking property of bio-briquettes, sufficient air flow is maintained between the briquettes during continuous combustion such as in a fireplace. As a result, the bio-briquettes have superior combustion-sustaining properties, and do not die out in a fireplace or other heater even when the air supply is decreased. This makes it easy to adjust the combustion rate.

3. Since fibrous biomass is intertwined with the coal particles, there is no fear of the fused ash in the coal adhering and forming clinker-lumps during combustion. Instead, the ash falls in a sandy form through the grate. Therefore, aeration is maintained to stabilize the combustion state. Furthermore, since no clinker is formed, the ash contains very small amounts of unburned coal.

4. The bio-briquettes are formed under high compressive force. Because of this, the desulfurizing agent and the coal particles strongly adhere to each other, and they effectively react during combustion. With the addition of a desulfurizing agent at a ratio of approximately 1.2-2 of Ca/S, 60-80% of the sulfur in the coal is fixed in the ash.

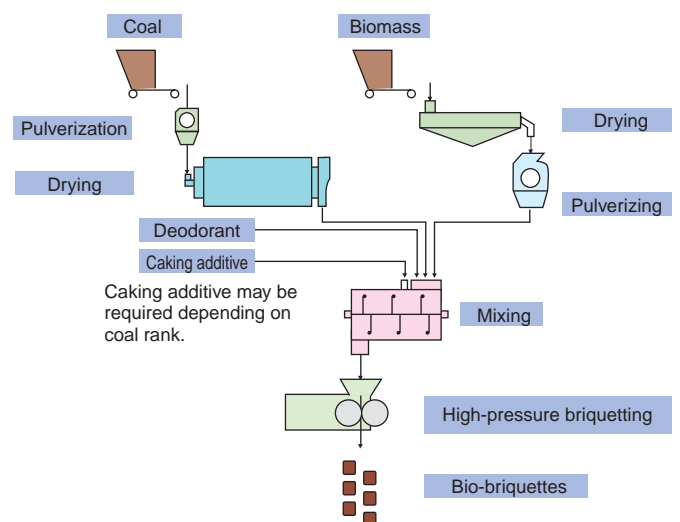


Fig. 3 Basic process flow for bio-briquette production