4D2. Low-rank Coal Upgrading Technology (UBC Process)

Research and development: Japan Coal Energy Center; Kobe Steel, Ltd.
Project type: Joint research of technologies applicable in coal-producing countries
Period: 2001-2004 (4 years)

Technology overview

1. Background and process overview

Brown and sub-bituminous coal, accounting for about 50% of coal reserves, are referred to as "low-rank coal." Applications are limited due to its low heating value and spontaneous combustibility. Unlike bituminous coal, however, much of the low-rank coal has low sulfur/ash content. Therefore, if it could be efficiently upgraded and converted into high-grade, high-heating coal, it would greatly contribute not only to a stable energy supply but also to environmental conservation. A low-rank coal upgrading technology (UBC process) has been developed to enable the effective use of such low-rank coal. This process, an adaptation of the slurry dewatering technique in the brown coal liquefaction process, consists of 3 stages: 1) slurry preparation/dewatering, 2) solid-liquid separation/solvent recovery, and 3) briquetting (Fig. 1).

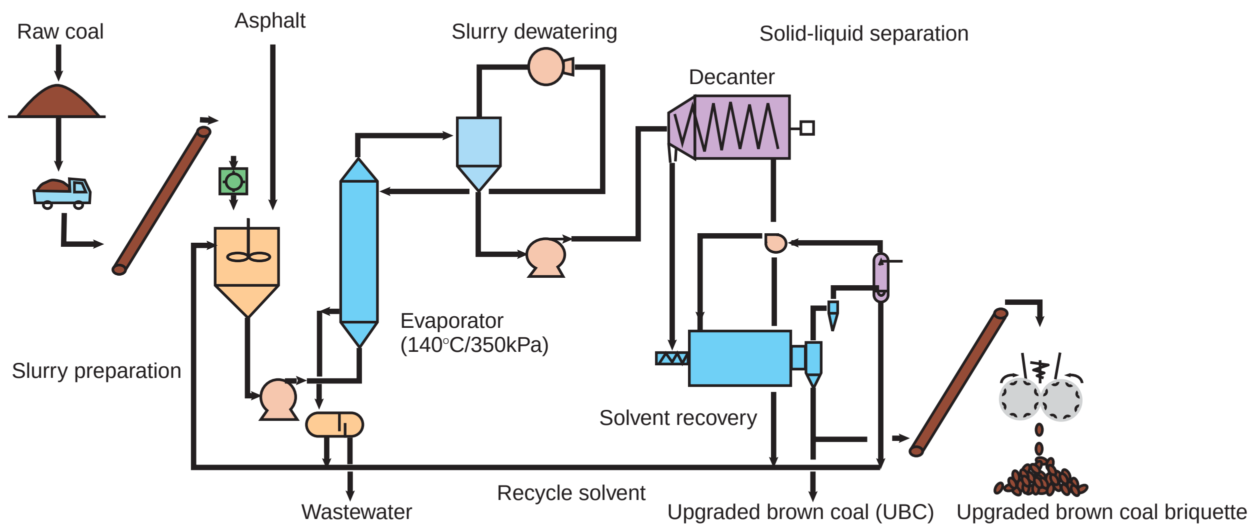

Fig. 1 UBC process for upgrading low-rank coal

During the slurry preparation/dewatering stage, after the pulverized high-moisture low-rank coal has been mixed with circulating oil (normally light petroleum oil), and then laced with heavy oil (such as asphalt), and heated in a shell and tube-type evaporator, moisture is recovered as water vapor. This water vapor is sent to the shell side of the evaporator, after being pressurized by a compressor, to use the waste-heat as a heating source, providing substantial energy savings during the dewatering stage. Low-rank coal also contains numerous pores and the moisture within them is removed in the course of evaporation. During that time, laced heavy oil is effectively adsorbed into the surface of the pores, thus preventing spontaneous combustion. Moreover, the water-repellant nature of heavy oil functions to prevent the re-adsorption of moisture and accumulation of the heat of wetting (Fig. 2).

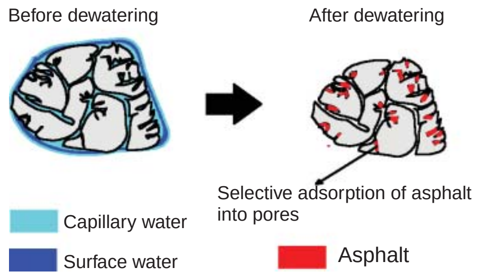

Fig. 2 Fundamentals of low-rank coal upgrading

At the stage of solid-liquid separation/solvent recovery, after most of the recycled solvent is recovered from the dewatered slurry by a decanter, the recycled solvent remaining in the pores of the upgraded coal is recovered by a tubular steam dryer.

Since the upgraded coal produced in the UBC process is still in a powder form, for transportation to non-local customers it is formed into briquettes. Using a double roll briquetter, the upgraded coal can easily be briquetted without the use of a binder. Photo 1 shows a picture of upgraded-coal briquettes.

Photo 1 Briquetted UBC

2. Development target

1) Upgrading cost

Assuming that the FOB price of bituminous coal with a heating value of 6,500 kcal/kg is $20/ton, that of 4,500 kcal/kg sub-bituminous coal should be around $13/ton in calorific equivalents. When upgrading this coal to a calorific value of 6,500 kcal/kg, the treatment cost guideline should be set at $7/ton. However, taking into account the advantages of low-rank coal, such as its low ash content, the R&D team has set a development target to keep upgrading costs equal to or less than $10/ton.

2) Thermal efficiency in the upgrading process

The upgrading of low-rank coal needs to provide a higher thermal efficiency than that obtained from the direct firing of the same low-rank coal when considering the entire process involved, from UBC production to power generation. Thus, the minimum thermal efficiency target for the upgrading process has been set to 90%.

3. Development progress and results

The heating value of upgraded coal, though it varies depending upon the characteristics of the coal, has been improved to around 6,500kcal/kg, and its spontaneous combustion problem has also been successfully suppressed. It has also been confirmed that briquetted upgraded-coal is similar to normal bituminous coal when it comes to ease-of-handling and re-crushing.

Furthermore, upgraded coal, when combusted, quite easily burns itself out to leave almost no un-burned portion even under low-NOx combustion conditions, exhibiting excellent characteristics as a fuel.

4. Future assignments and prospective commercialization

The Japan Coal Energy Center and the Research and Development Agency of the Ministry of Energy and Mineral Resources served as the driving force for building a 5 ton/day (on a raw coal basis) UBC process demonstration plant in Cirebon, Java Barat province, Indonesia. Operation of the demonstration plant was completed in 2005 (Photo 2).

In low-rank coal producing countries, including Indonesia, coal producers are highly interested in the UBC process and are hoping for early commercialization.

Photo 2 Low-rank coal upgrading demonstration plant

Reference

1) Toru Sugita et al., UBC (Upgraded Brown Coal) Process Development, Kobe Steel Engineering Reports, 53, 42, 2003.