4A3. Brown Coal Liquefaction Technology (BCL)

Research and development: New Energy and Industrial Technology Development Organization; Kobe Steel, Ltd.; Nissho Iwai Corp.; Mitsubishi Chemical Corp.; Cosmo Oil Co., Ltd.; Idemitsu Kosan Co., Ltd.; and Nippon Brown Coal Liquefaction Co., Ltd.
Project type: Development of Brown Coal Liquefaction Technology; Development of Basic Liquefaction Technology; Coal Liquefaction International Cooperation Project; and other projects
Period: 1981-2002 (21 years)

Technology overview

1. Background and process overview

Economically recoverable coal reserves are expected to total about one trillion tons, about one-half of which are comprised of low-rank coal such as sub-bituminous coal and brown coal. Coal has a larger ratio of reserves to production (R/P) than that of oil and natural gas. For the effective utilization of coal, however, the effective use of low-rank coal is essential. Low-rank coal contains a large amount of water, but unlike bituminous coal and other higher rank coals, has an autoignition property in a dry state. Consequently, brown coal liquefaction technology development has progressed with the aim to use it to contribute to a stable supply of energy in Japan by converting the difficult-to-use low-rank coal into an easy-to-handle and useful product, or by using it to produce clean transportation fuels such as gasoline and diesel oil.

As shown in Figure 1, the BCL process has four stages: the slurry dewatering stage, where water is efficiently removed from low-rank coal; the liquefaction stage, where liquefied oil production yield is increased by using a highly active limonite catalyst and bottom recycling technology; the in-line hydrotreatment stage where the heteroatoms (sulfur-containing compounds, nitrogen-containing compounds, etc.) in the coal-liquefied oil are removed to obtain high quality gasoline, diesel oil, and other light fractions; and the solvent de-ashing stage where the ash in coal and the added catalysts are efficiently discharged from the process. In Asian countries, economic growth has steadily increased energy demand, and countries possessing low-rank coal resources, such as Indonesia, anticipate commercialization of the technology.

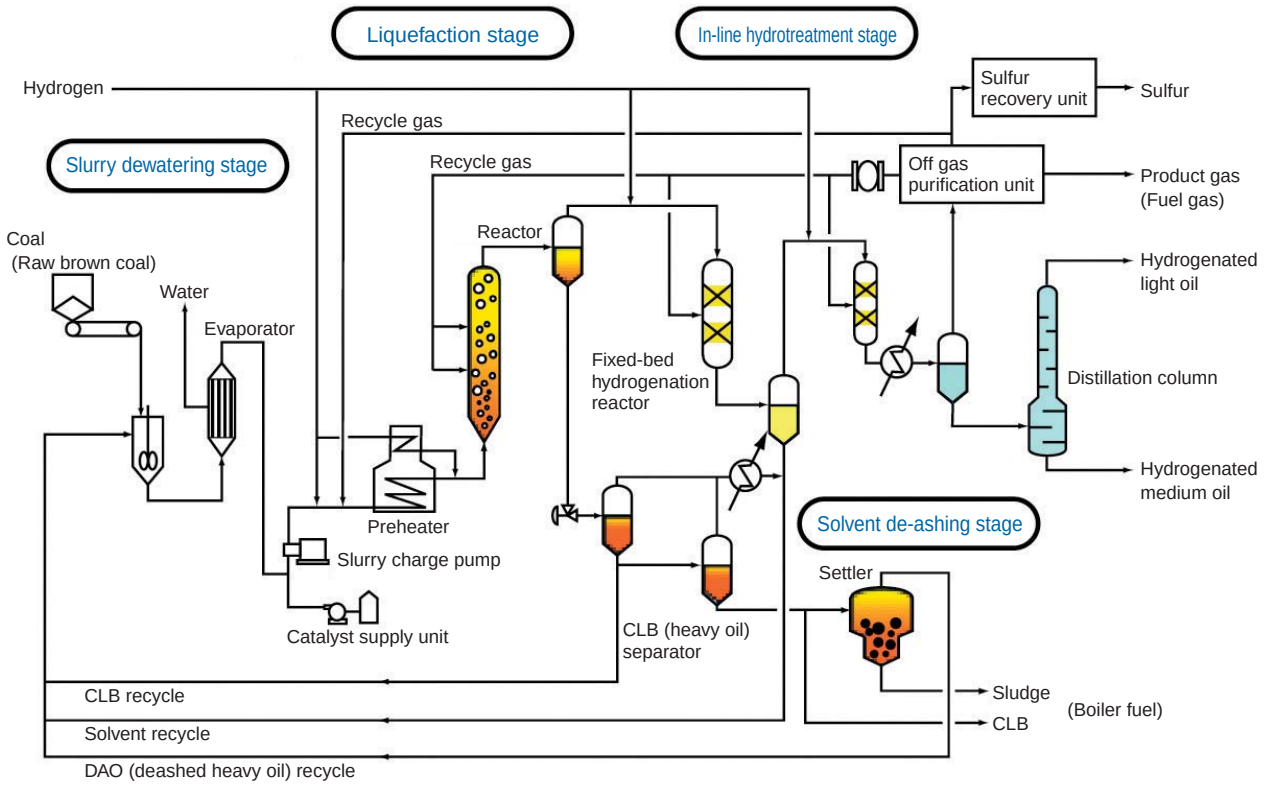

Fig. 1 Flowchart of BCL process

2. Development objectives and developed technology

A pilot plant (Photo 1) study conducted under the governmental cooperation of Japan and Australia set the following technical targets:

(1) High liquefied oil production yield: 50% or greater

(2) Long-term continuous operation: 1,000 hours or greater

(3) High deashing performance: 1,000 ppm or less

(4) Establishment of new slurry dewatering process. Through four years of operation and study (1987- 1990), all of the above targets were achieved. Furthermore, scale-up data necessary to construct commercial liquefaction plants and expertise on plant operation were obtained through pilot plant operation. During the study period, (the 1990s), however, oil prices were low and supplies were stable worldwide. Thus, further improvements in the economics of the coal liquefaction process were vequired and cleaner liquefied oil was demanded owing to increased environmental concerns. Accordingly, a bench-scale plant (0.1 t/d) in Kobe Steel, Ltd.'s Takasago Works was constructed to conduct a study for improving the process. Results of the study included the development of: a limonite catalyst, an extremely active catalyst compared to existing liquefaction catalysts, and one possessing superior handling properties, such as excellent crushing characteristics; a method to maintain catalytic activity through bottom recycling technology; an in-line hydrotreatment technology that significantly improves the quality of coal-liquefied oil; and various improvements for increasing operational reliability. Through the development work, an improved BCL process (Improved Brown Coal Liquefaction Process: refer to the flowchart on the preceding page) that significantly improves the economics, reliability, and environmental compatibility of the brown coal liquefaction process was established.

Photo 1 Fifty t/d Pilot plant (Australia)

3. Progress and development results

On the basis of a memorandum of understanding on cooperative coal liquefaction research between the Agency for the Assessment and Application of Technology of Indonesia and the New Energy and Industrial Technology Development Organization, a study team carried out surveys and liquefaction tests of low-rank coal in Indonesia beginning in 1994, in addition to screening candidate coals for liquefaction. Furthermore, the team endeavored to increase the technical abilities of the Indonesian engineers through technical training and the supply of liquefaction testing equipment. In 1999, the study team selected three candidate sites for a liquefaction plant in Indonesia, and carried out a feasibility study on coal liquefaction, including an economic evaluation. The feasibility study revealed that coal liquefaction would be economically feasible at a given oil price.

4. Issues and feasibility of practical application

Due to steady economic growth, energy demand in Asian countries is rapidly increasing. Since the stable supply of energy from Asian countries to Japan significantly contributes to the energy security of Japan, brown coal liquefaction technology that utilizes low-rank coal will play an important role.

References

1) Shunichi Yanai and Takuo Shigehisa: CCT Journal, Vol. 7, p. 29, 2003.

2) Report of the Results of the International Coal Liquefaction Cooperation Project, Cooperative Study of Development of Low Grade Coal Liquefaction Technology, 2003.