FEASIBILITY STUDY ON COAL LIQUEFACTION PROJECT IN KALIMANTAN

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Abstract
Tulisan ini secara ringkas nejelaskan studi kelayakan pabrik pencairan batubara peringkat rendah yang berlokasi di dekat pantai Kalimantan Selatan (coastal Case) sebagai alternatif lokasi dari studi kelayakan yang sebelumnya dilaksanaan untuk lokasi pedalaman di Banko, Sumatera Selatan (inland case). Tujuan utama studi ini, pertama untuk menginvestigasi efek lokasi pabrik terhadap keekonomian proyek, dan kedua untuk mengidentifikasi poetnsi kelayakan proyek pencairan batubara pabrik pabrik komersial pionir di Indonesia. Didandingkan dengan aksus pedalaman, lokasi dekat pantai mempunyai keunggulan dari segi penghematan biaya konstruksi dan biaya transportasi sampai dengan 10%. Analisis finansial dengan metode DCF telah memberikan hasil yang menjanjikan bahwa pabrik pionir kapasitas 12.000 ton per hari sudah dapat memproduksi bahan bakar minyak bersih dari batubara bersih tahun 2011, pada tingkat harga US$ 23.3/bbl (FOB, Berau Lati) and US$ 26.1/bbl (FOB, Mulia Satui) dengan harga aktual (COE=1.0). Pabrik pinoir dengan kapasitas kecil (3.000 tob per hari) masih dinilai layak dengan insentif berupa harga batubar alebih rendah, bunga pinjaman llunak dan lainnya.

Keywords: *banko coal, mulia satui, berau lati, metode DCF, pencairan batubara*

1. INTRODUCTION

The direct coal liquefaction technology has undergone significant improvements over the past decade by continuing R&D and achieved a high level of technical readiness. Therefore, it must be a good opportunity to evaluate the advanced technology applied in this country having huge amount of low-rank coal resources. Kobe Steel Ltd., entrusted by NEDO Japan, and BPPT have conducted the feasibility study since 1999 for the production of ultra clean fuels from the low-rank coals. The major objectives of this study are to first investigate the effect of plant location on the project economics, and then to identify the potential feasibility of direct coal liquefaction project at a pioneer commercial plant in this country. Last fiscal year of 2002, possible plant site and feedstock coal were altered to those at coastal location in Kalimantan. This paper presents the summary of the study

2. CONCEPT OF COMMERCIAL PLANT

2-1. Major Concept

On the basis of the technical information acquired in the pioneer plant investigations, as well as the Indonesian situation, a concept of a pioneer plant is summarized in Table 1. Among the several candidate coals, Mulia and Berau coals have been selected as feedstock coals after pre-investigation
on coal quality, coal reserves, mining cost and surrounding infrastructure. The pioneer plant have capacity of 3,000 t/d, 6,000t/d and /or12, 000t/d on moisture and ash free coal basis. The relatively small capacity, 3,000 t/d scale was newly adopted in place of 30,000 t/d full capacity to reduce initial investment.

Table 1. Major Concept of Coal Liquefaction Plant

Plant Site	Satui, South Kalimantan & Berau Lati, East Kalimantan
Plant Scale	3,000t/d; 6,000t/d; 12,000t/d
Feed Coal	Mulia coal (moisture 35.0% wb, ash 5.1%db) Berau coal (moisture 25.1% wb, ash 7.3%db)
Product	Synthetic transportation fuels, LPG, Chemicals
Process Applied	Improved BCL Process
Hydrogen Source	Coal Gasification by HYCOL Process
Shipping Terminal	Satui, South Kalimantan & Berau Lati, East Kalimantan

A seaside area close to coal mine is to be selected as the plant site and following two coal mines were proposed for the coastal case study. Mulia and Berau coal mines are located near the Java Sea and Berau river, therefore the plant locations were naturally sited near the mine mouth as shown in Figure 1.

Figure-1. Possible Plant Site at Coastal Area for Coal Liquefaction

Mulia coal in Satui South Kalimantan and Berau coal in East Kalimantan would be the most favorable feedstock coals from the following reasons, good quality for liquefaction and gasification, enough reserve as shown in Table-2 and good location near the coast

Table 2 Reserves of Proposed Coals Mulia coal

(MMton)	Measured	Indicated	Inferred	Total
East Mulia	154.9	96.4	158.2	409.5
West Mulia	335.7	21.5	80.5	437.7
Total	490.6	117.9	238.7	847.2

Berau coal

(MMton)	Measured	Indicated	Inferred	Total
Lati	204	593	343	1,140
Binungan	326	110	3	439
Total	530	703	346	1,579

2.2. Applied Liquefaction Process

BCL process (Brown Coal Liquefaction process) was applied for the liquefaction of Indonesian low-rank coals (Anon, 1997). This process is a single stage liquefaction process consists of four operations ; slurry de-watering, hydro-liquefaction, inline hydrotreatment, and solvent de-ashing. BCL process is believed one of the best processes among the direct liquefaction technologies for the low-rank coals developed through the world i.e.:

- High efficiency slurry de-watering unit is adopted in which the recovered steam is compressed and re-used for preheating the slurry.
- Highly dispersed Indonesian limonite catalyst is used in the hydro-liquefaction unit that brings high oil yield.
- Inline hydrotreatment unit, which is installed at the downstream of liquefaction reactor, brings excellent quality of product oil with extremely low sulfur and nitrogen contents.
- Solvent de-ashing unit brings high oil yield by recycling the DAO (De-Ashed Oil) to the liquefaction reactor for further hydrogenation of heavy fraction.
- These features have been demonstrated by the 0.1t/d Bench Scale Unit in Japan and the 50 t/d Pilot Plant in Victoria Australia.

2.3. Hydrogen Source

There are the two sources for production of hydrogen gas, which is essential feedstock for the coal liquefaction. In this study, the entrained coal gasification (HYCOL) process were adopted for hydrogen generation in view of difficulty of supply natural gas which generates hydrogen via steam reforming.

2.4. Feed Stocks and Products

Feed stocks required and products from the pioneer plant are shown in Table 3.

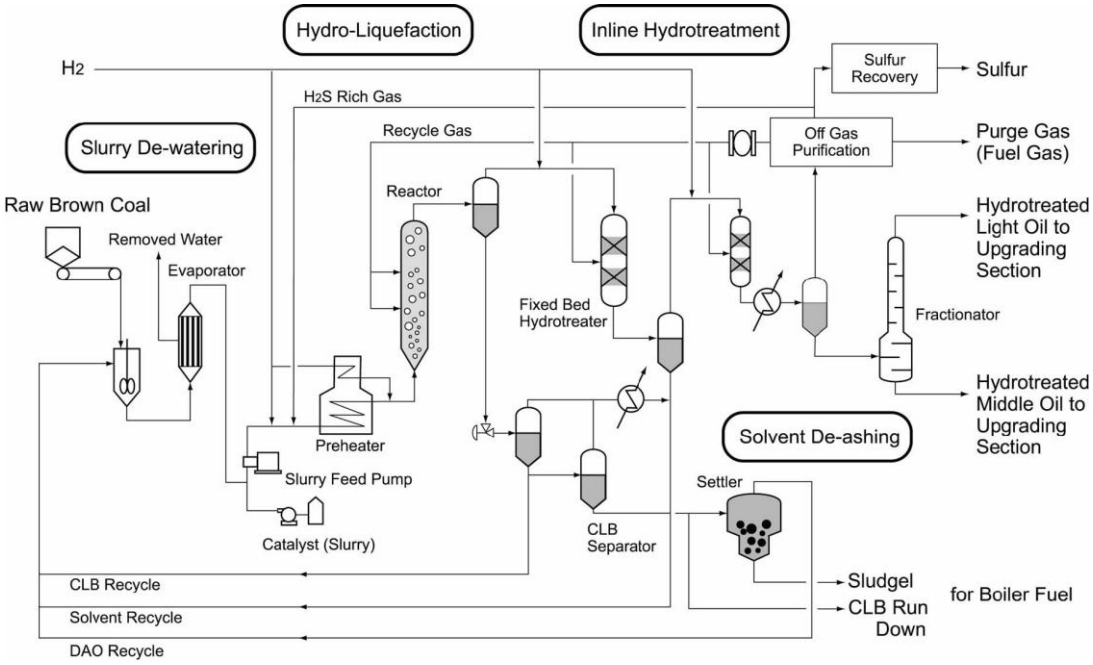


Figure 2. Simplified Flow Diagram of BCL Process (Brown Coal Liquefaction Process)

Table.3. Feed Stocks and Products

	Plant Scale	unit	3,000t/d	6,000t/d	12,000t/d
Mulia Coal	Coal Consumption	t/d raw coal	8,800	17,600	35,200
	Oil Production	bbl/d	13,500	26,900	53,800
Berau Coal	Coal Consumption	t/d raw coal	7,640	15,300	30,600
	Oil Production	bbl/d	13,500	27,000	54,000

In the case of 6,000t/d plant, the plant would produce liquefied clean oil at approximately 27,000 barrels every day from the raw coals of approximately 15,300 (Berau) and 17,600 (Mulia) tons which include coal for gasification and boiler sections (Anon, 1997; Anon, 2002; Anon, 2003).

3. PROCEDURE OF ECONOMIC ANALYSIS AND LIQUEFIED OIL PRICE ESTIMATES

Based on the technical results obtained in this study, estimates were made as to the selling prices of product oils with fixed return on equity (ROE:10%) ratio. The net cash flow of each year from the year of construction commencement to the last year of operation is converted to an equivalent in the first year of operation by using a discount rate. The oil selling price required in the first year of operation is determined on the assumption of fixed Return On Equity (ROE) so that the total of the discounted annual cash flow is zero. On the other hand, Indonesian government announced that the domestic fuel oil prices will be no longer subsidized in near future, which means the domestic fuel oil prices will follow the international market prices. ROE was checked against the recent international market prices.

4. RESULT AND DISCUSSION

4.1. Construction Cost

To obtain the construction cost estimates, the exponential method was generally applied. Scale-up or scale-down factors were set for each section by considering its specification and characteristics. The overall construction costs of the 3,000t/d, 6,000t/d and 12,000 t/d pioneer

plant in Indonesia are presented in Table 4. These costs include not only for liquefaction plant but also for pipeline and shipping terminal. Mulia and Berau coal liquefaction plant at the coastal areas are lower in construction cost by approximately 10% than that of coal liquefaction plant at the in-land mine mouth location with the following reasons:

- Lower moisture or ash content of Mulia and Berau coal leads
- Lower construction cost in coal handling, slurry dewatering and wastewater treatment sections.
- The in-land transportation costs for equipment and bulk materials are drastically reduced.
- Shipping cost of product oil is reduced because the long pipeline system is no longer required.
- Easy access to the plant site reduces costs for construction design,
- Transportation of heavy machines for erection, construction management etc

Table 4.Construction Costs of Commercial Plant

Plant Scale	Mulia Satui		Berau Lati	
	MMUS$	US$/daily bbl	MMUS$	US$/daily bbl
Cost for 3,000 t/d single train	799.8	59,450	808.3	59,870
Cost for 6,000 t/d single train	1,342.1	49,880	1,357.7	50,280
Cost for 12,000t/d double train	2,368.2	44,010	2,399.3	44,430

4.2. Summary of Economic Assumptions

Summary of assumptions for financial analysis is shown in Table 5. In order to carry out the price estimate in US$, all prices in 2002 were converted to US$ and then calculation have been made using interest rates, inflation rates, etc applicable to USA.

Table 5. Estimated Selling Price at Shipping Terminal

Raw Coal Price $/t	
Mulia	13(cap .6,000t/d) 13(cap.12,000t/d) 12(cap.30,000t/d)
Berau	12(cap. 6,000t/d) 12(cap.12,000t/d) 11(cap.30,000t/d)
Exchange Rate	1 US$=120Yen= 9,500rp
Land Price	Berau : free Lati: 1.5 US$/m2
Unit Labor cost	9,800 US$/man.yr
Taxation	Municipal property tax: 0.1%, Corpo-rate Tax: 30%
Crude Equivalent factor	1.00
Construction/operation period	4 years/25 years
Operation Factor	310 days/year
Equity Ratio	25%
Maintenance cost	3%/year on construction cost
Return on Equity (ROE)	Standard 10%/yr
Bank Interest Rate Long Term	Long Term: 7% Short Term: 5%
General Inflation Rate	3.5% per year
Feed Coal Price Escalation	3.5% per year
Liquefied Oil Price Escalation	3.5% per year
Construction Cost Escalation	3.5% per year
Labor Wage Escalation	3.5% per year

The prices of the ultra-clean product oil, which will be sold from the years of operation commencement, were calculated. Table 6 shows the calculation results using the above conditions and assumptions (Base Case). The product oil will be enthusiastically received, if the price calculated is at least same price as of the petroleum product at any time given. The results are expressed in terms of actual selling prices with 10% return on equity. For example, in the case where construction for a 12,000t/d pioneer plant will commence from 2007, and the products will be sold from 2011, the selling price at the shipping terminal will be varied from 23.3US$/bbl (Berau case) to 26.1US$/bbl (Mulia case) at a base of real value (excluding general inflation) condition. These prices are well lower than the price of in-land mine mouth case(Anon, 2002; Anon. 2003).

Table 6. Product Oil Selling Prices at Shipping Terminals

Shipping Terminal		Plaju	Api-Api
Crude Oil Equivalent Price			
6,000t/d	US$/bbl	25.6	25.7
12,000t/d	US$/bbl	22.5	22.6
30,000t/d	US$/bbl	20.2	20.3

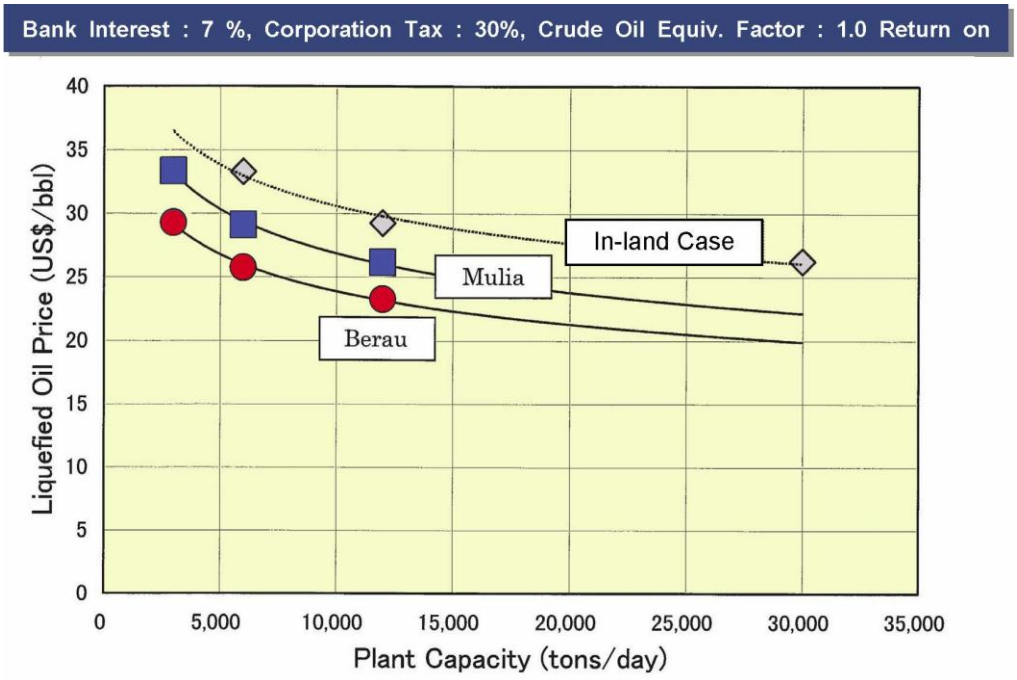
Notes

Prices shown are actual value excluding general inflation.

Construction starts in fiscal year of 2007, and commencement in fiscal year of 2011

Figure 3 shows a correlation between the plant scale and the oil-selling price. If the recent

trend of petroleum oil product prices (Ave. 30.3US$/bbl) will be continued, minimum feasible plant scale will be in the range of 2,500t/d –



5,000t/d for coastal case and 1,1000t/d for in-land case coal respectively (Anon, 2002; Anon, 2003).

4.4. Return on Equity under the Market Price Mechanism

Since Indonesia faced the economy crisis occurred in the middle of year 1997, the subsidy for the domestic fuels has increased significantly. Such high subsidy forced the government to increase the domestic fuel prices gradually from 1998 until 2004 where the fuel prices will be no longer subsidized. When the domestic fuel prices will follow the international prices in the year 2004, each type of oil based fuel (OBF) will be priced around Rp 2,000 according to the estimation by Pertamina. If the liquefied oils can be sold at the price which deducts the processing and deliver costs at Pertamina from the market price, the actual selling price of liquefied oil at the terminals would be Rp 1,800 per liter or approximately 30US$/bbl as shown in Table 7.

Although the selling price of the liquefied oil is subject to the international market, if the product oil could be sold at 30$/bbl in 2011, ROE of Mulia coal case varies from 6.5% to 14.5% depend on the plant size. In case of Berau coal case, project feasibility become more realistic. In fact, ROE is boosted up from 10.8% to 17.6%. It is certainly significant improvements in ROE upon the previous study (see Table 8)(Anon, 2002; Anon, 2003).

Table 7. Possible Selling Price of Liquefied Oil at Terminal

Unit : Rp./liter

Type of OBF	Market Prices[*1]	Cost[*2]	Material Price	Liquefied Oil Yield % dafc	Selling Price
Premium	1,950	240	1,710	LO 28.8	1,710
Kerosene	2,150	220	1,930	MO 22.0	1,855
Diesel Oil	1,990	210	1,780		
Diesel Fuel	1,940	206	1,734	HO 12.7	1,349
Fuel Oil	1,540	191	1,349		
Average	-	-	-	-	1,693

[*1] It changes according to the international market price of oil.
[*2] Processing, distribution, transportation and overhead costs total

Table 8. Comparison of ROE under selling price of 30$/bbl (base case)

Plant Site		Mulia Satui	Berau Lati
3,000t/d	ROE %	6.5	10.8
6,000t/d	ROE %	11.3	14.9
12,000t/d	ROE %	14.5	17.6

5. SENSITIVITY ANALYSIS

The economic sensitivity analysis was carried out to inspect the impact of changes in raw coal

pricing and bank interest rate. Figure 4 shows that the decrease in both important conditions will bring the highest ROE, 16.2% (3,000t/d), 20.3% (6,000t/d) and 22.3% (12,000t/d) respectively.

These high ROE have never seen through the similar feasibility studies on the direct coal liquefaction. This gives also a significant impact on the feasibility of the liquefaction project. Several important technical innovations have been achieved over the last decade especially the development of the "Advanced BCL Process" followed by "Improved BCL Process". Current configurations that include slurry-bed liquefaction stage and in-line hydrogenation stage can produce distillate products having low heteroatom content with high hydrogen content. It can be believed that the good process, good location and good coal will realize a pioneer plant in this country.

The governments can do much to encourage the establishment of a coal liquefaction industry not only for the expenditure of treasury funds, but also taxation, acceleration of plant depreciation etc. Such incentives could lead the additional opportunity of employment and the revenue collections, particular in Kalimantan region.

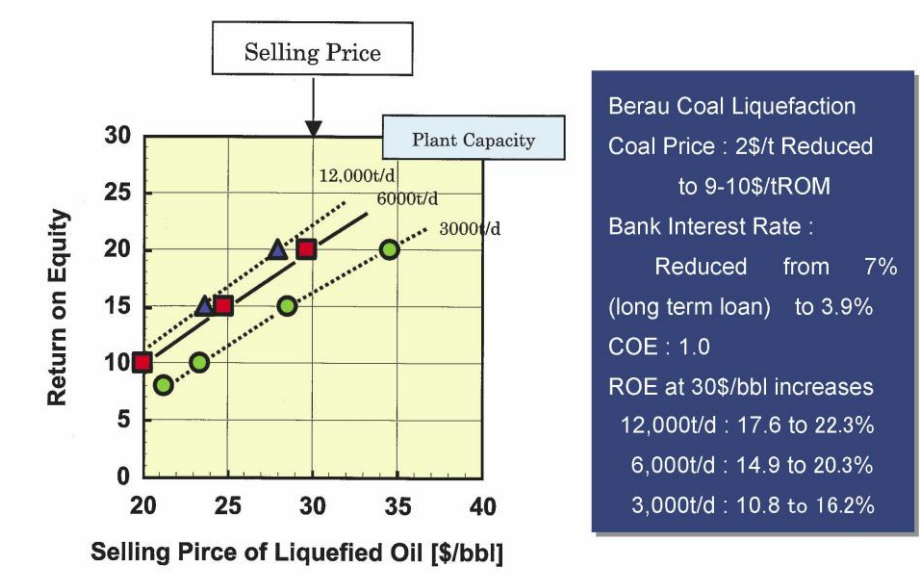


Figure 4. Effect of Coal Price and Bank Interest Rate on Return on Equity

6. CONCLUSION

The feasibility studies on the coastal location have been carried out to compare the in-land mine mouth case.

Because of the superior quality of Mulia and Berau coal in liquefaction characteristics, the possibility of construction for a pioneer liquefaction plant has been in progress by this study.

Comparing with the in-land case, the coastal case has advantages in saving construction cost and shipping cost for up to 10%.

The financial analysis based on DCF method has brought perspective results that the proposed pioneer plant which has 12,000t/d capacity could produce ultra-light clean fuel oils in the year of 2011, at prices of: FOB at Berau Lati US$ 23.3/bbl at actual price (COE=1.0). FOB at Mulia Satui US$ 26.1/bbl at actual price (COE=1.0)

A small pioneer plant (3,000t/d) may be feasible if some incentives could be expected such as lower coal price, lower interest loan and other. The governments can do much to encourage the establishment of a coal liquefaction project not only
for the expenditure of treasury funds, but also taxation, acceleration of plant depreciation etc.

Such support could lead the additional opportunity of employment and the creation of new industrial sectors, particular in the east Kalimantan region

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