

Reviewing Analysis of Petroleum Downstream Industry Potential in Riau Province

Tomi Erfando^{1,*}, Ira Herawati¹

¹ Petroleum Engineering Department, Universitas Islam Riau

* Corresponding author : tomierfando@eng.uir.ac.id

Received : May 15, 2017. Revised : May 25, 2017, Accepted : May 31, 2017, Published : 1 June 2017

DOI: 10.24273/jgeet.2017.2.2.304

Abstract

Petroleum downstream industry in Riau Province is still not optimal. The data shows that from 98,892,755 barrels lifting oil each year only 62,050,000 barrels could be processed in refinery unit II Dumai operated by PT Pertamina. There is a potential of 35-40% of downstream industry. Indonesian Government through The Ministry of Energy and Mineral Resources declared the construction of a mini refinery to boost oil processing output in the downstream sector. A feasibility study of development plan mini refinery is needed. The study includes production capacity analysis, product analysis, development & operational refinery analysis and economic analysis. The results obtained by the mini refinery capacity is planned to process crude oil 6000 BOPD with the products produced are gasoline, kerosene, diesel and oil. Investment cost consist of is capital cost US\$ 104419784 and operating cost US\$ 13766734 each year with net profit earned US\$ 12330063/year and rate of return from investment 11.63%

Keywords: Petroleum, Downstream Industry, Riau, Mini Refinery

1. Introduction

Riau Province is one of the biggest oil and gas producers in Indonesia. The oil and gas comes from several operational areas spread in Bengkalis Regency, Siak Regency, Pelalawan Regency, Indragiri Hulu Regency, Kampar Regency, Rokan Hulu Regency, Rokan Hilir Regency and Meranti Islands Regency. Based on the official report released by the Ministry of Energy and Mineral Resources (lifting.migas.esdm.go.id), Riau Province's crude oil lifting for 2016 reached 98,892,755.93 barrels, this production is the highest in Indonesia. Meanwhile, natural gas production is estimated at 18,814,803.69 MMBTU.

The large potentials in the oil and gas sector should be developed to increase local and national revenues. Oil and gas can be used as basis for regional economic development, so that oil and gas activities can be used as a stimulus to move the local economy ([Murbuni, 2001](#)). In the upstream sector (exploitation), some fields in Riau Province have entered on tertiary recovery or enhancing oil recovery. Meanwhile, in the downstream sector, it can be said that it is not optimum yet because in Riau Province there is only one petroleum refinery unit II managed by PT Pertamina in Dumai City. The refinery has an installed capacity of 170,000 barrels per day ([Risdiyanta, 2015](#)). If we calculate a year only able to process 62.05 million barrels of oil produced from oil and gas fields in Riau. There are still 35-40% unprocessed oil production.

One of the efforts to improve performance in the downstream sector of oil and gas is to encourage the development of industries based on the processing of oil and natural gas ([Directorate General, Oil and Gas, Ministry of Energy and Mineral Resources 2015](#)). This is stated in UU no. 3 tahun 2014 on Industry, the role of government in pushing forward industrial sector forward done in a planned and arranged systematically in a planning document.

The plan set by Indonesia Government for Riau Province in the downstream sector is constructing of a mini refinery with a capacity of less than 20,000 barrels per day. Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 22 of 2016 concerning the Implementation of Small-Scale Oil Refinery (mini refinery) where there are two development mini refinery plans, cluster II Selat Panjang covering EMP Melacca Strait and Petroselat and cluster III Riau covering Tonga, Siak, Langgak, West Area and Kisaran.

The construction of a mini refinery has several considerations which are required lower cost and shorter time than building a large refinery, increasing fuel demand, close proximity to oil production wells that will save transport shipping cost and environmentally friendly minimum water and solid waste or air pollution ([Sulistyaningrum, 2015](#)). A preliminary analysis of development plans is required to provide a clearer picture of the technical and economic aspects of the project. This research is also expected to be a reference by stakeholders in taking policy. The policies are

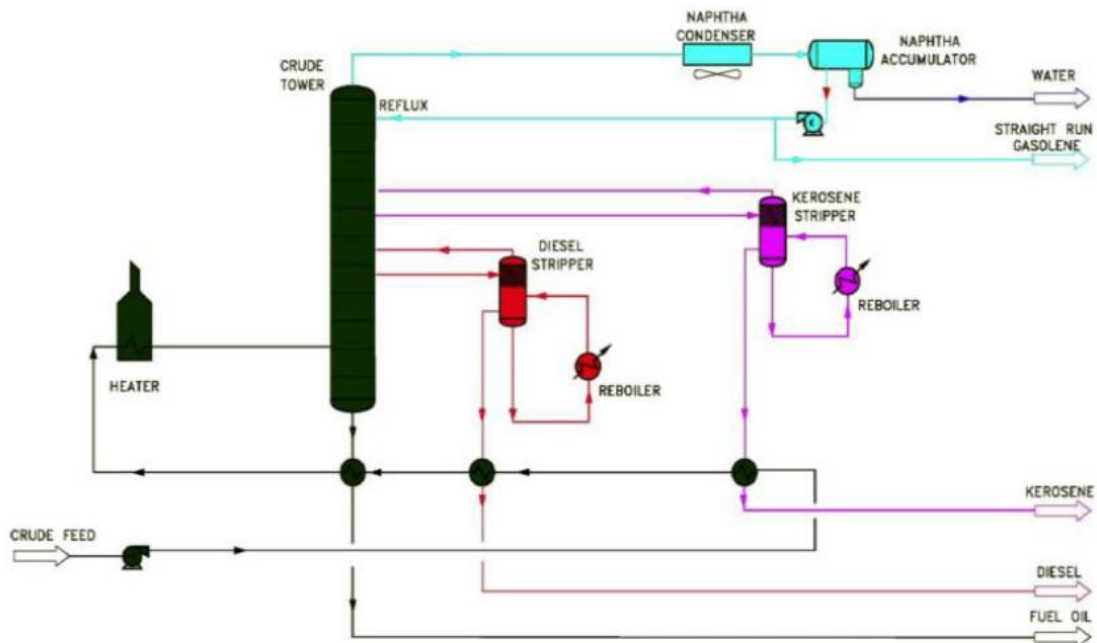


Fig. 1. Example of Processing Flow on a mini refinery (McGuire, 2014)

expected to increase local revenue from not optimized yet oil and gas production.

2. Methodology

This study is a descriptive research, which will provide an overview of the potential of downstream industries in Riau province. The problem identification is viewed from the not optimal processing of petroleum production in the downstream sector. Currently downstream capacity is only capable of processing 60-65% of petroleum production through the presence of Pertamina refinery in Dumai and reviewing the plan issued by the government for the construction of a mini refinery as one of the upgrading efforts in the downstream industry.

Focus of the research is cluster II covering Tonga, Siak, Pendalian, Langgak, West Area and Kisaran. One of the oil samples taken from Siak Field, Sumatran Light Crude (SLC). Testing of distilled point is done in the Petroleum Engineering laboratory of Universitas Islam Riau.

The data used are primary data from the laboratory test results for the distillation point and secondary data from several sources such as production data from the lifting report of the Ministry of Energy and Mineral Resources, legal products applicable in Indonesia in the form of Laws, Government Regulations and Minister Regulations. Other secondary data are obtained from a variety of sources that can be trusted for its validity.

The analysis undertaken to get conclusions are as follows the first assessment of the ability of the supply of raw materials to determine the production capacity in the downstream industry. The second determination of the product type (fraction) generated through the sample test. The

third determination of the amount of costs required in the construction of a mini refinery, the cost will be grouped into two namely the cost of capital and operating costs (non-capital). The calculation method for the payment of capital costs by using linear depreciation over several years of production. The fourth economic analysis of the project involves adding value from raw materials to processed products and return on investment.

The oil and gas sector comprises three business groups: upstream, intermediate and downstream. The upstream sector is getting mining permits, exploration and exploitation. Refining, processing, and marketing activities are downstream oil and gas industry activities (Nugroho, 2004). In this research will focus on the downstream industry of oil and gas is refining/ processing of petroleum. Processing flow in mini refinery operations has many configurations that match the needs and desired output product (McGuire, 2012). This is an example of a processing flow on a mini refinery fig. 1.

Operating processes at oil refineries can be classified into 5 stages (Risdyanta, 2015), as follows:

1. Distillation process, is a distillation process based on the difference of boiling point; This process takes place in the atmospheric distillation column and the Vacuum Distillation Column. Vacuum distillation process is a second phase of the crude oil processing (Ocic *et al*, 2000).
2. The Conversion Process, which is a process for changing the size and structure of hydrocarbon compounds. Included in this process are:
 - a. Decomposition by thermal cracking and catalyst (thermal and catalytic cracking)
 - b. Unification through alkylation process and Alteration polymerization through

isomerization process and catalytic reforming.

3. Treatment process. This is intended to prepare the hydrocarbon fractions for further processing, also to be processed into the final product.
4. Formulation and mixing (blending) process, is the process of mixing hydrocarbon fractions and addition of additive to obtain the final product with certain specifications.
5. Other processes include waste treatment, sour-water stripping, sulfur recovery, heating, cooling, hydrogen-making and other supporting processes.

The implementation of the economic feasibility study for modern oil and gas projects is divided into main scopes (Shaallan, 2012):

1. Economic Feasibility Study
2. Petroleum industry
3. Risk and uncertainty analysis
4. Use of software
5. Contract of oil and gas
6. Case study

In this study only discussed about economic feasibility studies and case studies on the downstream oil and gas industry.

3. Result and Discussion

3.1 Production Capacity Analysis

Supply of raw materials becomes one of main factors in the consideration in development of downstream industry of oil and gas sector. The raw material is the availability of crude oil and natural gas in the operating area that goes into the planning. Based on the policy issued by the Ministry of Energy and Mineral Resources of the Republic of Indonesia there are 2 clusters which become development planning in Riau Province, namely Cluster II and III. Cluster II in Strait Panjang covers the work area of EMP Melacca Strait and Petroselat and cluster III Riau covers the work area of Tonga, Siak, Pandalian, Langgak, West Area and Kisaran. In this research will focus on cluster III Riau. samples tested in the Petroleum Engineering Laboratory of Islamic University of Riau. Production capacity of each working area in cluster III, as shown in the fig. 2 below:

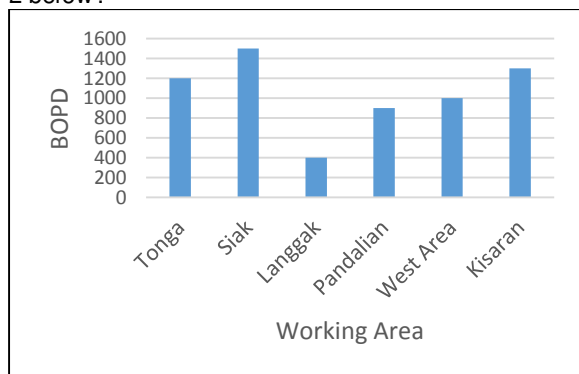


Fig. 2. Production capacity of each working area in cluster III

Mini refineries offer the possibility of phased construction and the flexibility of quick and easy upgrade to reflect changes in product demand (Mama, 2015). Total production for mini cluster II refinery work area is 6300 BOPD. The details are Tonga 1200 BOPD, Siak 1500 BOPD, Langgak 400 BOPD, Pandalian 900 BOPD, West Area of 1000 BOPD and Kisaran estimated production will reach 1300 BOPD. The ability of raw material supply in the form of crude oil is a reference in the development of production capacity for mini refinery development in cluster III which is 6000 BOPD. This figure considers the condition in the future, whereas principle oil production will decrease (decline) if special treatment has not done in the form of addition of production well, secondary and tertiary recovery. In the other side,

3.2 Refinery Products Analysis

Based on the official report released by the Ministry of Energy and Mineral Resources (2016) the type of oil produced in Riau is generally Sumatran Light Crude or SLC. One of the SLC samples taken directly in the field was tested by crude oil distillation. This test aim to determine fractions generated from crude oil. However, limitation of the testing equipment it is not being used to obtain the distilled distillation result but rather the combination of all the distillates which are the refluxable feedstock to obtain the fractionated fuel. The table below test results of

Table 1. Distillation test results one of SLC sample

weight of crude oil (gr)	Crude oil density (gr/cc)	Bubble point temperature (°C)	Initial Boiling Point Temperature (°C)	°API	Residual Weight (gr)
79.11	0.791	180	185	47.6	68

In this experiment to get the distillation result from crude oil, the crude oil sample was heated by using electric heater and crude oil destilator. Before getting the distillation results, the sample will pass the bubble point. It is the temperature at which the gas phase begins to release from the oil, marked by appeared bubble burst first time. After passing the bubble point the sample will reach the boiling point core, it is the temperature at which the first droplet of the distillation. After reaching the initial boiling point the sample will continue to produce the distillate until it reaches the end boiling point, it is the temperature at which the sample no longer produces the distillate and only residual remains. Based on our experiment the bubble point temperature obtained is 180 °C, the initial boiling point temperature obtained is 185 °C and the boiling point end temperature obtained is 250 °C. Additional data is required for test result to be divided into distillation fractions, the data obtained from the results published by Emergency Canada,

Emergencies Science and Technology Division (2006) divide into 5 main groups as follows:

In mini refinery operations it is advisable to process petroleum into products with simple straightforward atmospheric distillation aimed at reducing costs. This simple distillation is diesel fuel and / or kerosene production with by-products of gasoline and naphtha. However, it is not possible to make a second phase vacuum distillation can filter components of fuel oil from the first atmospheric tower into clean diesel oil and heavy residual oil.

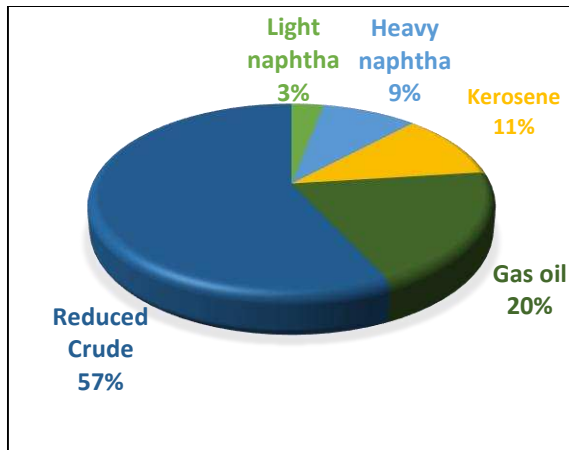


Fig. 3. Fraction of SLC Distillation

The addition of a secondary process can provide better value and quality for the final product to be produced (Risdiyanta, 2015). The process will provide consequences required investment cost that will increase. These secondary processes include cracking, catalic reforming, polymerization and so on.

In future, as for the quality of the refined products, specifications are no longer set by customers and vehicle manufacturers only, but also by environmental regulations. To reduce emissions from automobiles, reformulated gasoline and diesel fuel, with low sulfur and high cetane number, have been introduced in the 1990's (Stanislaus, A., Qabazard, H., & Absi-Halabi, M., 2000).

3.3 Development & Operational Refinery Analysis

The refinery configuration refers to a study by Jones (2004) who has prepared a mini refinery project plan with the same capacity of 6000 BOPD. In the refinery development project the main component of cost are cash inflow and cash outflow (Shaallan, 2012). Cash inflow is derived from the proceeds from sale of product from the refinery. Cash Outflow (expenses incurred) consists of capital cost for building refineries, refinery operating cost and purchases of raw materials, state taxes to be paid on the based on agreed contacts. The cost of capital will include several working groups in construction of this mini refinery as follows:

Table 2. Capital cost estimate

Scope	Cost (US\$)
Engineering	6530832
Site Facilities	27061760
Process Units	
Crude Unit	8037680
Naphtha HDS	6324000
Reformer	18228000
Unicracker	16120000
Other Infrastructure	1987720
Contingency	13108499
Working Capital	7021293
Total Project Cost	104419784

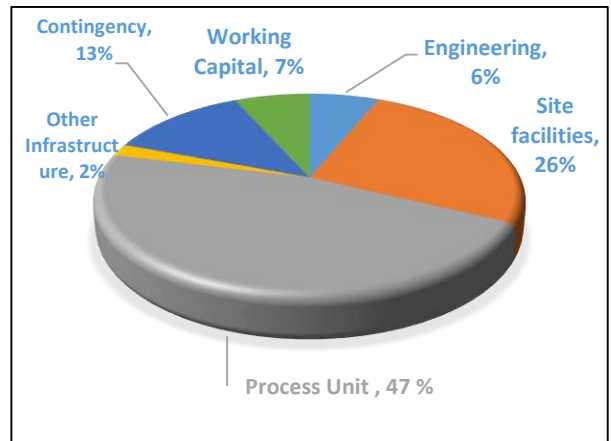


Fig. 4. Percentage capital cost

In table 2 and Fig. 4, The greatest cost is required for construction of process unit (crude unit, naphtha HDS, reformer, unicracker) of US \$ 48709680 or 48% of total capital cost. Construction of site facilities have a percentage of 26% equivalent to US \$ 27061760. Project work has aspects of uncertainty especially the price of raw materials in the market for it needs to be taken into account unexpected costs in the mini refinery work, the unexpected cost is the third largest cost group to be spent In capital investments worth US \$ 13108499 (13% of total capital cost).

The cost of mini refinery work is estimated to be 7% of the total capital cost or US \$ 7021293. Engineering design in feasibility study will cost US \$ 6530832, this cost has a 6% percentage of the cost of capital. The last group is the cost of operating support facilities such as communication networks, security systems, monitoring and others costing US \$ 1987720 only 2% of the cost of capital.

Table 3. Daily operation cost

Scope	Cost (US\$)
Natural Gas	15195
Electricity	2702
Water	211
Chemical	8859
Labor	9759
Maintenance Supplies	992
Total Operation Cost	37717

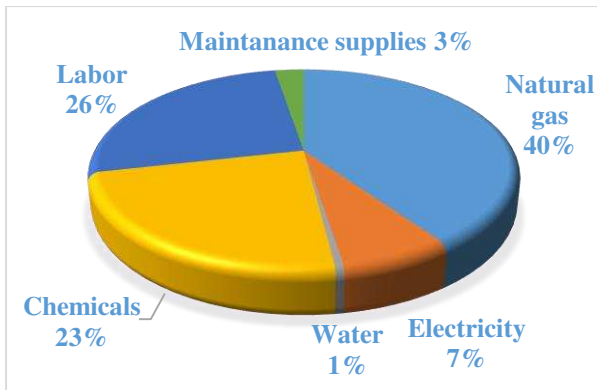


Fig. 5. Daily operation cost

After the refinery is built, it is expensive to operated. Fixed cost include personnel, maintenance, insurance, administration and depreciation. Variable cost include crude feedstock, chemicals and additive, catalysts, maintenance, utilities and purchased energy (such as natural gas and electricity). To be economically viable, the refinery must keep operating costs such as energy, labor and maintenance to a minimum (Canadian Fuels Association, 2013; Jbnes & Pujado, 2006)

Table 3 and Fig. 5 show the amount of operating costs consisting of purchasing natural gas as the main energy source, electricity, water, chemicals, labor and supply management needed per day. In the operation of mini refineries would require a considerable energy, certainly can not depend on electricity supply from PLN for it needs to be allocated gas purchase costs for the plant. Gas can come from existing fields in the operating area, the cost of which is set at US \$ 15195 or 40% of operating costs. Electricity needs are still supported by electricity coming from PLN where the allocation is not large, the funding for electricity originating from PLN is estimated at US\$ 2702.

Labor cost is the second highest percentage of 26% or US \$ 9759. Chemicals as a supporter of processing raw materials daily cost US\$ 8859 (23%). Maintenance supplies and water are not significant at only 3% (US \$ 992) and 1% for US \$ 211 of operating cost on a daily basis. If the operating expenses are calculated within a year then total operating cost is US\$ 13766734.

3.4 Economic Analysis

The most widely used measure economic performance in the refining industry is return on investment (ROI) (Pirog, 2007). This section will focus on that parameter. The calculation can certainly be a consideration for investors and governments in taking policy towards the project. The following shows the calculation results of the details of investment components.

Table 3. Rate of return investment

Item(s)	Amount (US\$)
Total Project Cost	104419784
Total Operation Cost	(13766734)
Raw material	(131400000)
Depreciation	(6526236)
Product added value	163834448
Net profit	12330063
Rate of return	11.63%

Increase of product value is obtained from sale of processed products in this case gasoline, kerosene, diesel and oil with total sales of US \$ 163834448. The production capacity of mini refinery to be built is 6000 BOPD operational time in a year 365 days then the need for raw materials is 2190000 Barrel assuming average world oil price of US\$ 60 / Barrel then the total expenditure for raw materials is US\$ 131400000. Depreciation (straight line method) from mini refinery is US\$ 6526236 / year, the value is the capital cost divided by the estimate mini refinery project time, that is assumed to be 16 years (Jbnes, 2004).

Net profit is derived from the total value added of the product produced minus cost of raw materials, operating cost, and depreciation. The addition of the value of each barrel final product generated amounted to US \$ 15.85. The rate of return on investment of 11.63% this value is low in oil and gas projects usually set a return of investment of 30% The low rate of return on this investment can be concluded that the construction of a mini refinery is not economical (Utami, 2013). The economic feasibility of a project is not the only factor to decide whether to build or not but must look to local need of a region (McGuire, 2012). During the construction, commissioning and operation of the refinery, massive labour employment, both skilled and unskilled was generated in the market. This project also generated the secondary employment for other business like transport, manufacturing, power, market for the daily consumption by the labour, housing & construction in the project location (Chaudhuri & Ray, 2016)

4. Conclusions

Based on review for ,the conclusion reach as follow :

1. The production capacity of mini refinery is 6000 BOPD
2. Types of final product from mini refinery are gasoline, kerosene, diesel, and oil
3. Total capital cost of mini refinery development is US\$ 104419784 and annual operating cost is US\$ 13766734
4. Total annual net income is US\$ 12330063 and return on investment 11.63%

References

- Chaudhuri, S. & Ray, S., 2016. Social and economic impact analysis of vadimar refinery of essar oil : the case of a mega refinery p.17. Indira Gandhi Institute of Development Research (IGDR). Mumbai
- Cross, P., Desrochers, P. & Shimizu, H., 2013. The economic of petroleum refining understanding the business of processing crude oil into fuels and other value added product. Canadian Fuels Association.
- Directorate General, Oil and Gas, Ministry of Energy and Mineral Resources, 2015. Status sumber daya alam migas di Indonesia: cadangan, produksi dan outlook jangka menengah dan jangka panjang. Presented at Public Discussion for Essential Services Reform (IESR), Jakarta, 23 September.
- Environment Canada, Emergencies Science and Technology Division, 2006. Sumateraan light. http://www.etc-cte.ec.gc.ca/databases/Oilproperties/pdf/WEB_Sumatran_Light.pdf
- Jones, D.S.J & Pujado, P.R. (ed), 2006. Handbook of petroleum processing. Springer. AA Dordrecht, Netherlands.
- Jones, J.D., 2004. Feasibility study for a petroleum refinery for the jicarilla apache (rep.), Final project technical narrative.
- Ministry of Energy and Mineral Resource, 2016. Peraturan menteri energi dan sumber daya mineral no. 22 tahun 2016 tentang pembangunan kilang mini. <http://jdih.esdm.go.id/view/download.php?page=peraturan&id=1542>
- Ministry of Energy and Mineral Resources, 2016. Perhitungan realisasi alokasi lifting minyak mentah kumulatif s/d triwulan IV. <http://lifting.migas.esdm.go.id>
- Mama, C. K., 2015. Analysis: mini refining investment opportunities in nigeria. Africa's Barrel Equations p.8.
- McGuire, Dan, 2012. Mini-refinery feasibility overview. p.5. Refinery equipment, Texas.
- Murbuni, Sunoto, 2001. Pemberdayaan potensi daerah dalam kegiatan operasi industri hulu migas nasional. Proceeding Simposium Nasional IATMI, Yogyakarta, 3-5 Oktober.
- Nugroho, H., 2004. Pengembangan industri hilir gas bumi indonesia: tantangan dan gagasan. Perencanaan Pembangunan No. IX/September.
- Ocic, O.J, Gehrecke, S.K., & Perisic, B.J, 2000. Energy management in an oil refinery. World Petroleum Congress.
- Pirog, Robert, 2007. Petroleum refining: economic performance and challenges for the future. CRS Report for Congress
- Risdiyanta, 2015. Mengenal Kilang Pengolahan Minyak Bumi (Refinery) di Indonesia. 5(4): 46-54
- Shaalan, H. Y., 2012. Economic feasibility study for petroleum project (practical Aspects). Jurnal of Petroleum Research & Studies. 5: 26-47
- Sulistyaningrum, Eny, 2015. Peranan industri pengolahan minyak bumi melalui pembangunan kilang mini dalam meningkatkan perekonomian. Dipaparkan pada pertemuan ikatan sarjana Ekonomi Indonesia Cabang Surabaya.
- Stanislaus, A., Qabazard, H., & Absi-Halabi, M., 2000. Refinery of the future. World Petroleum Congress.
- Undang-Undang No. 3 Tahun 2014 Tentang perindustrian. <http://peraturan.go.id/inc/view/11e44c4e40b02a40a365313231323530.html>
- Utami, D.S & Kamila, I. 2013. Darurat pembangunan kilang baru. Corporate Communication Sekretaris Perseroan PT Pertamina. Jakarta. Juli. Hlm. 19