# Optimization Process for NGL Production in Indonesian Oil & Gas Field

Sanggono Adisasmito and Ekawati
*Chemical Engineering Department, Institut Teknologi Bandung, Bandung 40132, Indonesia*

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Abstract: A multinational gas company operating at Sumatra Island is processing 260 MMscfd of natural gas to produce around 110 MMscfd of gas sales and 26,000 bpd of NGL products. The purpose of this study is to optimize the operation in order to minimize the ratio of C2 / C3 at NGL products not to exceed 2.0%, in accordance with the technical specifications required for NGL product export. Prior to optimization, the C2 / C3 ratio of NGL products was more than 4.95%. The constraints to be considered in optimization are high gas flow rate to LP Inlet Compressor, which is limited at 260 MMscfd, CO2 removal unit which is limitted at 170 MMscfd, and high pressure on the Condensate Stripper column which is kept at 270 psig to avoid back pressure to inlet facilities. Optimization is done by changing the operating pressure on Condensate Stripper column, temperature on Pre-treatment Chiller and temperature on Condensate Stripper Reboiler. Optimization results showed that optimum conditions were achieved when the operating pressure on the Condensate Stripper column was changed from 250 psig to 267 psig, the temperature at Pre-treatment Chiller changed from 65ºF to 70ºF and Condensate Stripper Reboiler changed from 245ºF to 267ºF with these optimum conditions, the C2 / C3 ratio of NGL products has been reduced to 1.38% (simulation), 2.0% (actual). Optimization process has been succeeded in lowering the flared gas in Fixed Platform Unit from 5 MMscfd to not exceed 1 MMscfd.



## 1 INTRODUCTION

A company operating in Sumatra engaged in oil and gas processing with onshore production facilities, exports of gas using pipelines and exports of oil, condensate and LPG through marine (Fixed Processing Unit). The oil and gas resources come from wells scattering in several locations. These wells have their respective characteristics, some wells are oil wells with associated gas and non-associated gas wells. Currently the existing wells have been operating for more than 16 years. Some existing wells decrease production every year. They cannot be operated anymore because the well pressure is not sufficient to transport oil, condensate and gas due to gravity flow. In this condition, the production can be increased by reducing the operating pressure in bait facilities, and increasing the flow of gas and condensate from new wells so that it is expected that the wells with low pressure can flow gas and condensate based on gravity.

At new low pressure and the addition of new sources to the feed facility, this affects overall process performance of the facility. This study only discussed the parts of feed facilities, especially the production of condensate because condensate is a commodity that has higher economic value than gas. Moreover, the markets are not as high as in 2016. As a comparison, the natural gas price is set by the Indonesian presidential regulation about US $ 6 / MMbtu (Presidential Regulation No. 40 of 2016) while the price of crude oil Indonesia or Indonesian Crude Price (ICP) reached US $ 63.04 / barrel for Sumatra type of oil (ESDM, April 2018). In relation to the change of operating modes at the process facility from HP (operating pressure at 800 psig) - LP (operating pressure at 400 psig) to LP (400 psig) – LP (400 psig) and addition of feed gas capacity, the changing conditions give several concerns recorded in the production as mentioned below:

1. NGL production does not meet the technical specifications due to Ethane content with C2 /



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C3 ratio exceeds 2% at main production plant of NGL production.

2. High ethane content from main plant of NGL product is carried to fractionation plant which is has no De-euthanizer facility and affecting Propane product which is LPG product consisting of Propane and Butane obtained from Depropanizer and Debutanizer fractionation unit in which Ethane content at Propane LPG is exceeding 4.95 %. The LPG will be sent to marine at Fixed Processing Unit for export.
3. High Ethane content exceeding 4.95 % in Propane LPG affects the amount of flared gas in Fixed Processing Unit which reaches 5 MMscfd.

This study focuses only on NGL production, with changes in the current operating conditions from HP-LP operation mode to LP-LP causing changes in the amount of liquid entering Slug Catcher (V-201) due to phase change from the raw gas itself. In this condition, the component content should be in the liquid phase, and it turns into vapor phase due to flashing of the well. The vapor phase is again condensed into a liquid phase in the Pretreatment unit because the gas is cooled using Chiller (E-105) at a low temperature of 70ºF - 65ºF range. This causes some of the ethanes initially in the vapor phase turns into liquid phase and is carried back to the Inlet Separator (V-202) unit which is then embedded into the stripping process inside the Condensate Stripper (C-201). Before the optimized processing operating parameters in the Condensate Stripper cause Ethane to be included in the product under the Condensate Stripper (C-201) column which causes NGL products to not meet technical specifications, NGL products must have ethane content with a C2 / C3 ratio below 2.0 %. By not complying with the NGL product specifications, Ethane on the NGL product will be carried out to the Depropanizer fractionation process to produce Propane as mentioned above. Propane products are part of LPG products. When the LPG Propane does not meet the technical specifications, Ethane will be carried to export process, and the ethane will be flared at fixed processing unit (FPU) because Ethane will disturb exporting transportation.

When C2 / C3 ratio of the NGL product is around 4.95%, the flared gas in the FPU reaches 5 MMscfd. To reduce the Ethane content in Propane product and amount of flared gas in FPU, the Condensate Stripper operation is optimization to control Ethane content.

## 2 METHODOLOGY

Optimization process is done by case study simulation using ASPEN hysys V.10 software. Variables taken for optimization are to test some operating conditions:

a. The operating pressure of the Condensate Stripper column is varied over a range of 245 psig-260 psig,
b. Temperate Condensate Stripper Reboiler (E-106) is with range $245^0$F-$270^0$F and,
c. The temperature of the Pretreatment Chiller unit is varied in the range 65ºF-70ºF.

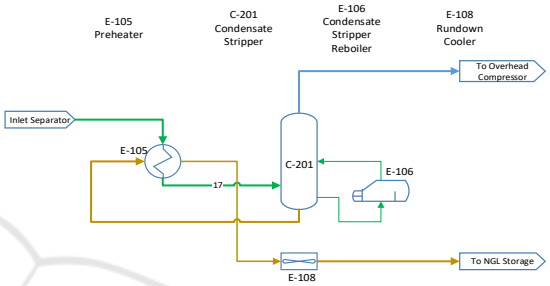


Figure 1: flow rate diagram of the Condensate Stripper system (C-201).

The fluid composition used for the simulation in this study is shown in Table 1.

Table 1: Gas Composition in Slug Catcher.

| Component | % mole | Component | % mole |
|---|---|---|---|
| CO2 | 21,31 | Toluene | 0,17 |
| Nitrogen | 1,53 | n-Octane | 0,21 |
| Methane | 43,64 | E-Benzene | 0,03 |
| Ethane | 4,89 | m-Xylene | 0,13 |
| Propana | 8,59 | o-Xylene | 0,03 |
| i-Butane | 1,67 | n-Nonane | 0,05 |
| n-Butane | 2,49 | n-PBenzene | 0,01 |
| i-Pentane | 1,09 | 124-MBenzene | 0,02 |
| n-Pentane | 0,89 | n-Decane | 0,04 |
| n-Hexane | 0,77 | n-C11 | 0,01 |
| Mcyclopentan | 0,20 | n-C12 | 0,01 |
| Benzene | 0,06 | n-C13 | 0,01 |
| Cyclohexane | 0,16 | n-C14 | 0,01 |
| n-Heptane | 0,29 | H2O | 11,71 |

The feed at the receiving facility is 104 MMscfd, liquid hydrocarbon of 9,487 bpd at LP Slug Catcher (V-219) and 136.5 MMscfd Hydrocarbon on HP Slug Catcher (V-201) and liquid hydrocarbon of 8,227 bpd with total water production of 4,100 bpd with maximum ambient temperature condition at $95^0$F and minimum at temperature $73^0$F.

The product under the Condensate Stripper column (C-201) is referred to as NGL, where NGL is delivered to the Depropanizer and Debutanizer fractionation process for Propane and Butane production which is part of LPG product. Technical specifications for LPG products as shown in Table 2, where the C 2 / C 3 ratio allowed on Propane LPG product) is about <= 2%.

Table 1: LPG Technical Specifications.

| Component | Units | Propane | Butane |
|---|---|---|---|
| Ethane | vol % | 2,0 (max) | |
| Propane | vol % | 96,0 (min) | 2,0 (max) |
| Butane | vol % | 2,5 (max) | 97,0 (min) |
| Pentane$^+$ | vol % | 0,01 (max) | 1,0 (max) |
| Olefins | vol % | 0,01 (max) | 0,01 (max) |
| Vapour Pressure at 100°F | psig | 200 (max) | 70 (max) |
| Water Content | ppm | 10 (max) | 10 (max) |

# 3 RESULTS AND DISCUSSION

## 3.1 Influence of Pressure on Condensate Stripper Column

After varying the process conditions according to the above data for the case studies, the selection of conditions for case studies is based on minimum and maximum conditions at the time when the production facility operates.

Figure 2 shows that at higher pressure of the Condensate Stripper column (C-201), the ratio of product C2 / C3 content at bottom product of the Condensate Stripper (C-201) decreases. Ethane will be reduced around 2% every 5 psi pressure increment. The total reduction of Ethane at NGL product is around 6% by increasing the pressure from 245 psig to 260 psig at a temperature of Reboiler Condensate Stripper at about $253^0$F. Column pressure of 260 psig as the minimum pressure is the reference for further studies. A pressure of 260 psig is assumed to prevent back pressure on the Separator Inlet (V-202) unit, where the operating pressure at overhead compressor is maintained at 270-275 psig. Based on the study, it is also seen that the influence of increasing pressure at Condensate stripper to reduction of NGL Product, is around 0.04% (7 bpd) feed per 5 psi pressure increasing, with a total production NGL reduction around 0.2% (26 bpd). This value is so small that it does not affect the amount of NGL production on Condensate Stripper (C-201). This effect is shown in figure 3.

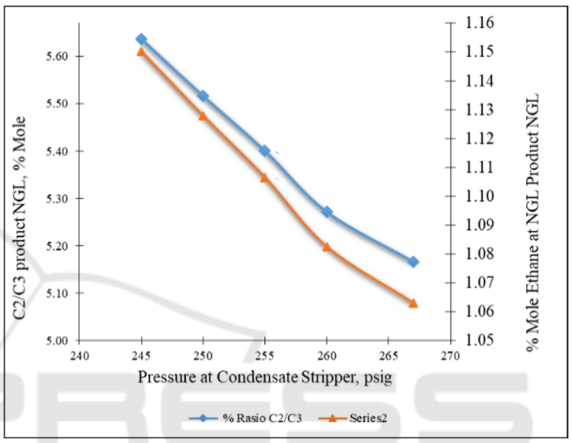


Figure 2: Effect of Operating Pressure at Column condensate stipper (C-201) to Ethane (C2) content to Product NGL at condensate stripper reboiler (E-108) $253^0$F.

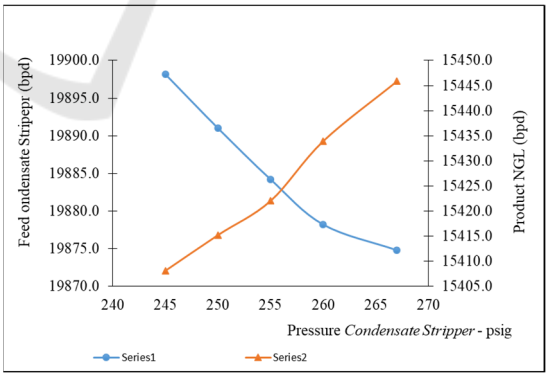


Figure 3: NGL production based on effect of pressure at condensate stripper (C-203) at condensate sripper reboiler (E-108) $253^0$F.

## 3.2 Influence of Temperature Chiller at Pretreatment Unit

Sensitivity analysis of Chiller Temperature Changes. Ethane content in some Condensate

Stripper Reboiler (E-106) temperature drops around 2-3$^0$F on Pretreatment Chiller (E-103):

1. Ethane content rises on average about 9% by reducing Pretreatment Chiller temperature around 2-3$^0$F. Totally Ethane Content on NGL product increases around 25% at NGL Product by reducing Pretreatment chiller from 70$^0$F to 62$^0$F at Condensate Stripper Reboiler (E-103) temperature 253$^0$F.
2. Ethane content rises on average about 10% on reducing Pretreatment Chiller temperature at 2-3, Totally Ethane Content on NGL product increases around 33% at NGL Product by reducing Pretreatment chiller from 70$^0$F to 62$^0$F at Condensate Stripper Reboiler (E-103) Temperature 255$^0$F
3. Ethane content rises on average about 20% on reducing Pretreatment Chiller temperature at 2-3$^0$F, Totally Ethane Content on NGL product increases around 80% at NGL Product by reducing Pretreatment chiller from 70$^0$F to 62$^0$F at Condensate Stripper Reboiler (E-103) Temperature 260$^0$F

The Effect of Pretreatment Chiller (E-103) temperature on various Condensate Stripper Reboiler can be seen in Figure 4 to Figure 9. Those figures show some effects of pretreatment chiller temperature at different condition of Condensate Stripper Reboiler Temperature, and form temperature at 253$^0$F, 255$^0$F, 260$^0$F. The Pretreatment chiller temperature is varied at case studies from temperature 60$^0$F to 70$^0$F.

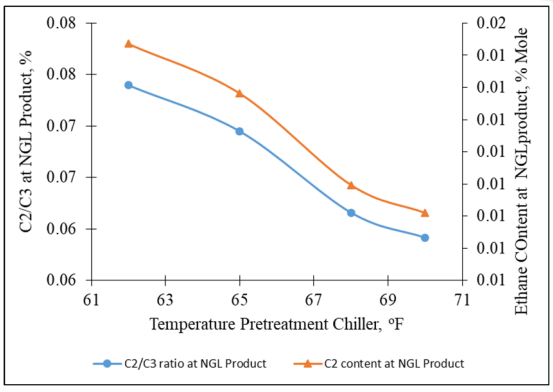


Figure 4: effect of Pretreatment chiller (E-103) temperature to Ethane Content at Condensate Stripper reboiler Temperature 253$^0$F.

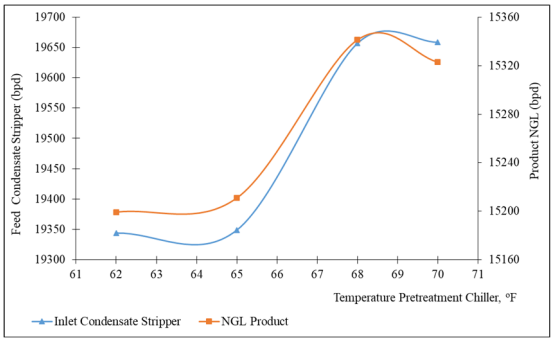


Figure 5: Effect of Pretreatment chiller (E-103) temperature to NGL Product Flow at Condensate Stripper reboiler Temperature 253$^0$F.

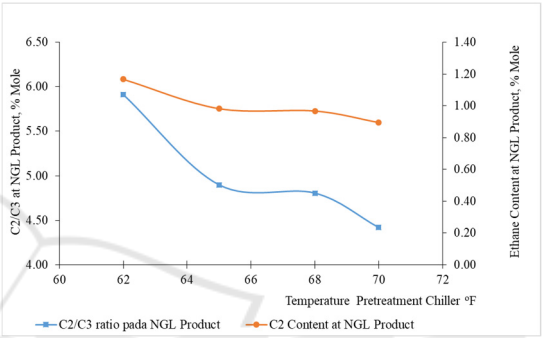


Figure 6: Effect of Pretreatment chiller (E-103) temperature to Ethane Content at Condensate Stripper reboiler Temperature 255$^0$F.

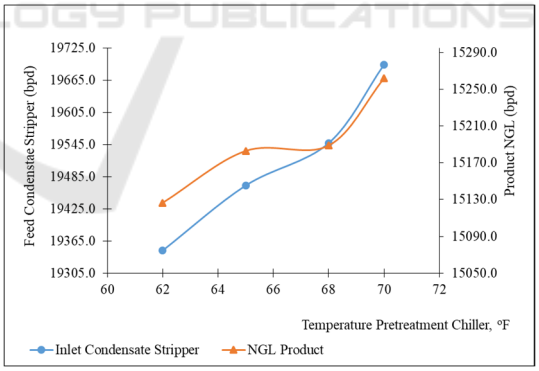


Figure 7: Effect of Pretreatment chiller (E-103) temperature to NGL Product Flow at Condensate Stripper reboiler Temperature 255$^0$F.

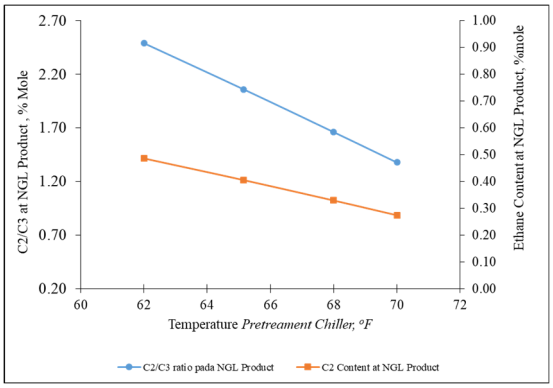


Figure 8: Effect of Pretreatment chiller (E-103) temperature to Ethane Content at Condensate Stripper reboiler Temperature 260$^0$F.

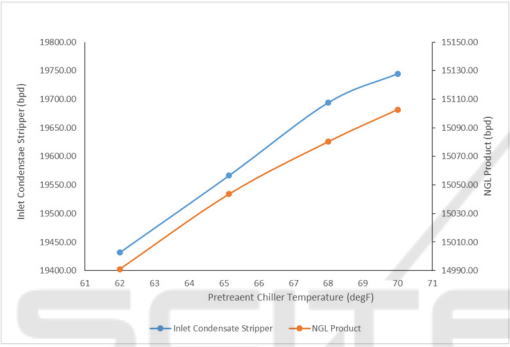


Figure 9: effect of Pretreatment chiller (E-103) temperature to NGL Product Flow at Condensate Stripper reboiler Temperature 260$^0$F.

## 3.3 Sensitivity Analysis of Temperature Changes at Condensate Stripper Reboiler

Change in Condensate Stripper Reboiler Temperature is shown in Figure 10.

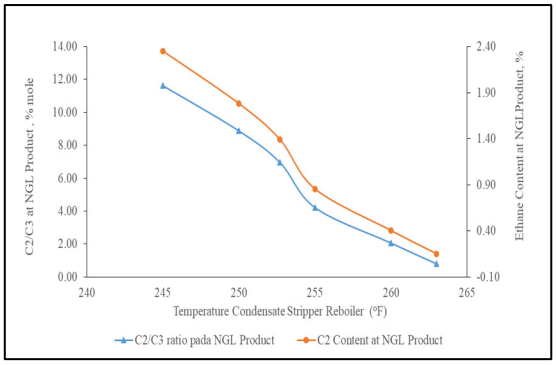


Figure 10: Effect Condensate Stripper Reboiler Temperature to Ethane Content at NGL Product at Condensate Stripper Pressure 260 Psig.

At 263$^0$F, it produces NGL with lower ethane content where C2 / C3 is about 0.8% while on reboiler temperature around 245$^0$F, it gives a considerable ethane content of about 11.62%.

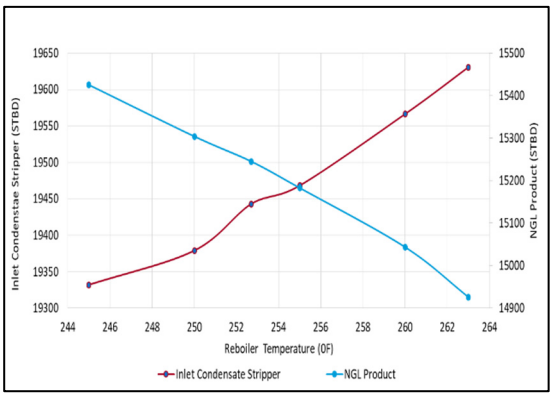


Figure 11: Effect of Condensate Stripper Reboiler Temperature to NGL Product at Condensate Stripper Pressure 260 Psig.

At Reboiler temperature 263$^0$F, NGL production is less than when Reboiler Temperature is at 245$^0$F, where NGL production reduces around 3.2% from (15425 BPD to 14926 BPD).

## 3.4 Flare Gas Analysis on Fixed Platform Unit

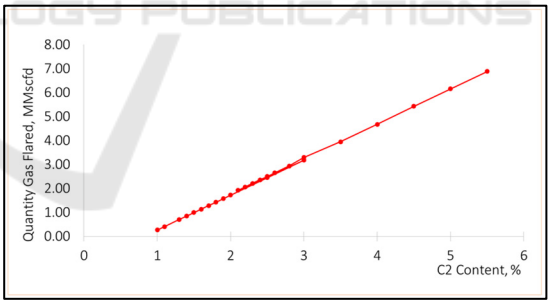


Figure 12: Gas Flare FPU Capacity.

Figure 12 shows that higher ethane content (C2) in NGL product. This will increase amount of gas flares on the FPU.

## 3.5 Field Testing

Based on the study above, the impact of optimized operating condition at Condensate Stripper, Condensate Stripper Reboiler and Pretreatment Chiller to NGL product specification and capacity of NGL product has been observed.

Figure 13 shows the condition before optimization in NGL plant.

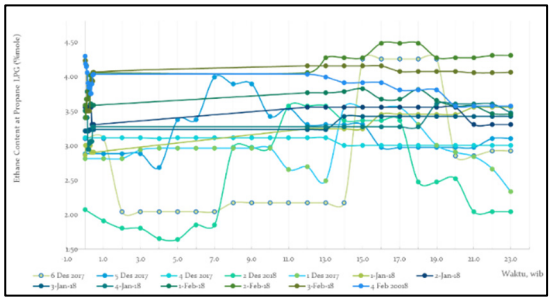

Figure 13: Ethane Content (C2) on Ethane Content on Propane Product Prior to Operation Change.

Figure 13 shows that Ethane content in NGL reaches 4.5%, with an average ethane content of about 3.3%. This Condition will affect on high flare in FPU unit. Quantity of flare at FPU is shown in Figure 12.

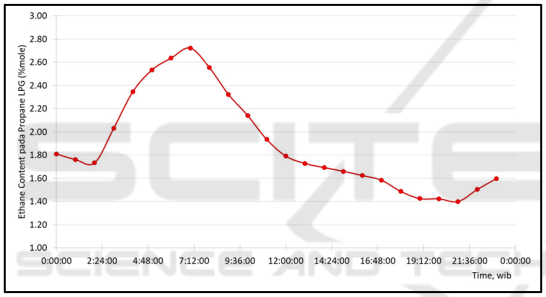


Figure 14: Ethane Content on Propane Products After Optimization of Operation Process in Plant A (March 31, 2018).

Figure 14 shows that the value of ethane content decreases although there is still a condition where content C2 ethane in LPG product is still high. However, at current condition, flaring in FPU could be minimized from 24 hours with rate around 5 MMscfd to 5 hours with rate lower than 1 MMscfd with ethane content at Propane around 2%.

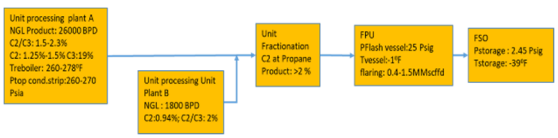


Figure 15: FPU Flare Gas After Optimization.

By performing optimization at Condensate Stripper, the flare gas can be reduced to 1 MMscfd or with range 0.4-1.5MMscfd from range 3-5 MMscfd.

# 4 CONCLUSIONS

This study has succeeded in improving operating performance as follows:

1. Ratio C2 / C3 in NGL product of 19000 bpd has dropped to 11.62% to 1.38% by increasing the reboiler temperature on condensate stripper (E-1) from $240^0$F to $260^0$F. It actually increases to $267^0$F, and raises the pressure on the top of the condensate column stripper (C-1) from 255 psig to 260 psig.
2. Flare gas in FPU (Fixed Platform Unit) can be reduced from 5 MMScfd to 1 MMScfd.
3. Ethane's content on Propane LPG which before being optimized was 4.5% (Maximum Limit 2%) has been lowered to 1.9% on average.

# REFERENCES

Uwitonze H., Hwan K., Lee I.,( 2017) : Modelling and improving natural gas condensate process with stripping and heat integration. *Chemical Engineering & Processing: Process Intensification* 118 (2017) 71–77.

Rahmanian N., Sakinah L., Jusoh Bt., Homayoonfard M., Nasrifar K., Moshfeghian M., (2016) : Simulation and optimization of a condensate stabilisation process, *Journal of Natural Gas Science and Engineering* 32 (2016) 453-464.

Esmaeili, A., (2010) : Optimization of effective Parameters on Reid Vapour Pressure (RVP) in an Iranian condensate stabilization plant and a back-up unit, *the 13th Asia Pacific Confederation of Chemical Engineering Congress, APCChE*, Taipei

Rahmanian, N., Ilias, I.B., Nasrifar, K., (2015) : Process simulation and assessment of a back-up condensate stabilization unit. *J. Nat. Gas. Sci. Eng.* 26, 730-736.

Benoy, J., Kale, R.N., (2010). *Condensate Stabilization*, Offshore World, Chemtech Foundation, India.

Lee J., Jo A., Lee H., Park K., (2015) : Design considerations for the condensate stabilization and liquefaction units in LNG FPSO, *International Society of Offshore and Polar Engineers (ISOPE).*

ESDM, Indonesian Ministry of Energy and Mineral Resources. *Indonesia Crude Price*, March 2018, available online https://migas.esdm.go.id/uploads/kumpul-icp/icp-maret-2018.pdf.