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The Impact of Gas Production Decline to LPG Recovery and Optimization Strategy to Prevent LPG Facility From Shutdown

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Abstract

The decrease in gas from the production well is caused by two main factors, namely the decline in formation productivity and the decrease in the production rate. The impact of the steep decline in production has resulted some risks in some operating equipment in both offshore and onshore production facilities being over capacity, not optimum in operation, and total shutdown in the LPG facility. To prevent this occurrence, alternatives are needed to maintain the rate of decline in production, both from the well side and from the equipment in the facility. Handling the production problems with right actions will return the producing wells with optimum capacity. In terms of equipment, for dynamic equipment such as rotating equipment, the equipment has a specific range of parameters or operating limits, thus modifications are required. Resizing the rotating equipment including the control system has been assessed and selected to be the most effective and efficient method to prevent the cessation of LPG plant in producing LPG. The direct impact of restaging the rotating equipment extends the lifetime of LPG plant and also gain some incremental of LPG recovery.

Keywords: *gas reduction, LPG facilities, gas production problems, gas economics*

1. Introduction

Oil and gas are the main commodities that play an important role in fulfilling energy needs in Indonesia. One effort to reduce dependence on petroleum is to increase gas utilization in Indonesia, including the use of Liquified Petroleum Gas (LPG). LPG is produced from gas associates and non-associate gas from gas fields, as well as oil refineries that produce LPG.

The LPG process begins with natural gas processing and refining crude oil to separate LPG from crude natural gas and oil, which is the beginning of the LPG refining process. LPG comes from two sources, with about 60% stripping from raw natural gas during natural gas processing and about 40% from LPG from the crude oil refining process. The LPG process continues with the fractionation of LPG, to separate the LPG into its constituent gases: propane, butane, and isobutene before being placed in the LPG cylinder tank for storage and distribution. One of the risk in gas and oil production is decline production rate. Production decline is classified as natural occurrence which can have effect on the non-fulfillment of sales to consumers. The main causes of non-optimum production in a well can be grouped into two (2), namely decreasing formation productivity and decreasing production rates. LPG production is dependent to gas production which also will creates issue if gas production decreases.

Cumulatively, during January - October 2018, LPG import volumes were recorded at 4.55 million tons, up from the same period last year of 4.49 million tons, this also makes the value of LPG imports cumulatively jump, from US $ 2.13 billion in January - October 2018, to US $ 2.54 billion. The high import of LPG is caused by the consumption of Indonesian LPG which now reaches above 7 million tons, 70% of total consumption is import. Indonesia's gas production is reaching 1.2 million barrels of oil equivalent per day

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(BOEPD). Suppose this amount is converted into LPG, it can still be sufficient for domestic consumption. However, the characteristics of gas in Indonesia make it difficult to convert gas to LPG.

Propane and butane will be LPG products. With increasing demand from LPG, stripping propane and butane into LPG are more attractive than being sold as natural gas through a gas pipeline. Gas fields that produce commercial volumes of propane and butane, it is recommended to add LPG stripping facilities. For static equipment, the excess capacity will not be critical issue. In contrary, for equipment that is dynamic - rotating - such as compressors, turbo expanders, the equipment has a specific working range or also called the operating limit. In the condition of gas decline production it is necessary to modify the facilities, especially rotating equipment. The modification is created by resizing rotating equipment at a lower capacity, including control mechanisms, including compressor restoring, turbo expander restaging, and resizing on CV, ASV, and other control mechanisms.

2. Methodology

SEI Company has Liquified Petroleum Gas Facilities (LPGF) which is designed to extract natural gas in sales gas into LPG products in the form of propane and butane. The design capacity of the LPGF gas flow inlet is 148 mmscfd. Through the extraction process, it is expected that the design can recover 98% propane and 99% butane from gas sales and produce 130 mmscfd of gas residue. Turndown ratio of this plant is 25%. This is mainly due to the limitation of the main rotating equipment namely turboexpander (expander and recompressor). The compressor residue inlet also has a turndown limitation that must be maintained so that the compressor can continue to operate. Figure 1 shows the flow diagram started from inlet gas entering the LPGF plant until final LPG product.

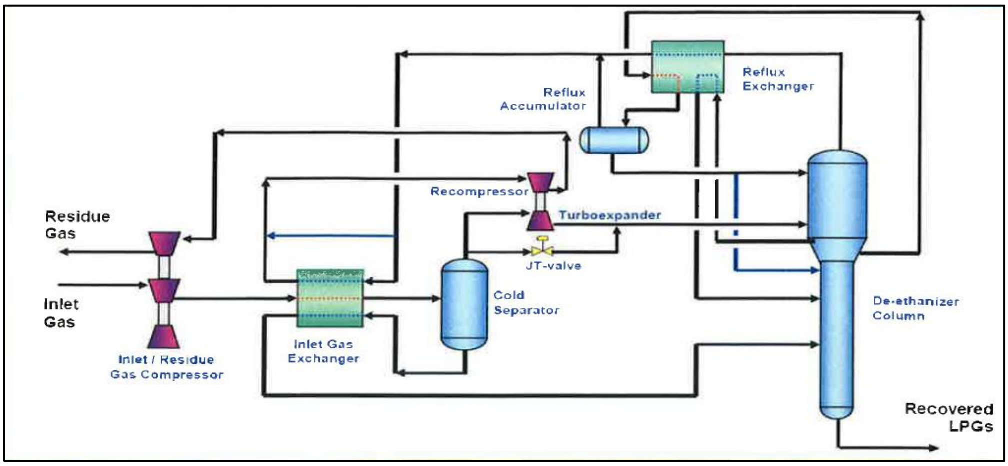

Figure 1. LPG Process Flow Diagram

The current low gas demand condition of around 32 mmscfd makes LPGF equipment operating at the lower limit of its turndown ratio. Based on the datasheet the minimum flow required for Turboexpander to operate is 33.2 mmscfd. However, in one condition, the minimum gas flow ever experienced was 28 mmscfd. Under these conditions, the Inlet Residue compressor operates in a "recycle mode" where the anti-surge valve is wide open. Based on this condition, SEI performed equipment optimization in LPGF to continue operating efficiently with a gas feed inlet below 30 MMscfd. With basis of internal assessment, the modification or equipment upgrade are as follows:

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- Perform restaging of compressor inlet residues

- Resize turboexpander or recompressor, include instrumentation equipment, pipe modification and insulation. While in the control valve replacement, five control valves are replaced. This control valve is specific for cryogenic service.

- Perform replacement of the control valve in accordance with low flow conditions.

Process simulation for this new condition is developed using Unisim to forecast the process parameter and resulted product from LPGF after compressor restaging. From Unisim simulation, the forecast shown comparison of turbo expander existing discharge temperature and after restaged (Figure 2). It shows that after restaging, temperature can reach lower than current condition and will optimize the LPG fractionation. Lower turbo expander discharge temperature leads to more liquid hydrocarbon, hence opportunities for higher C3+ liquid recovery. Besides temperature parameter, as shown in Figure 3, LPG yield after restaged is higher than existing LPGF.

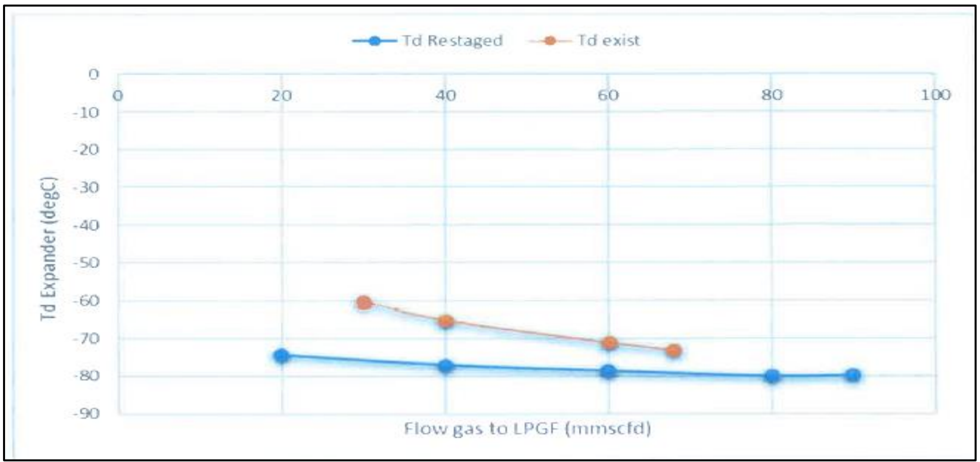

Figure 2. Turbo expander discharge temperature comparison

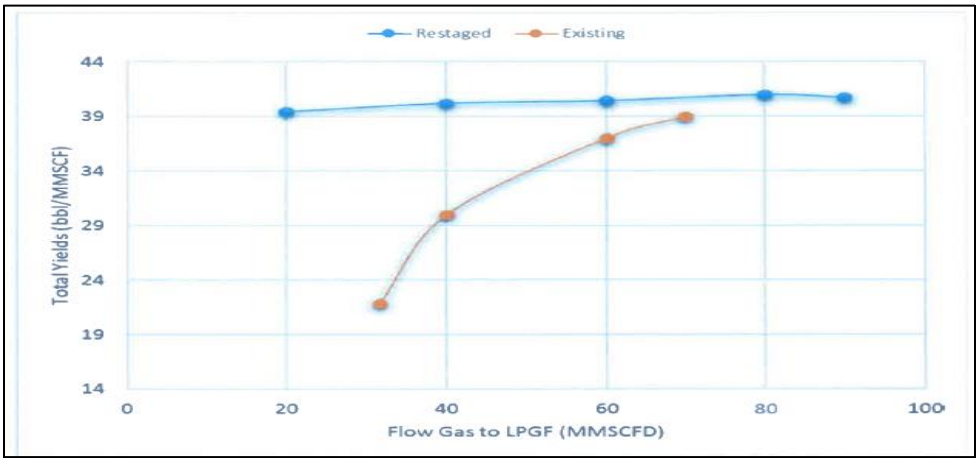

Figure 3. LPG yield comparison

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For the compressor performance, Unisim simulation also performed with three (3) cases.
Case 1. Low Feed Gas flow to LPGF at 40 MMSCFD
Case 2: Base Case - Gas flow to LPGF at 60 MMSCFD
Case 3: High Feed Gas flow to LPGF at 80 MMSCFD

Summary of compressors performance at each gas flow are shown in Figure 4. Figure 5 is the comparison of turbo expander efficiency before and after restaged. Turbo expander restaged will have higher efficiency than existing unit.

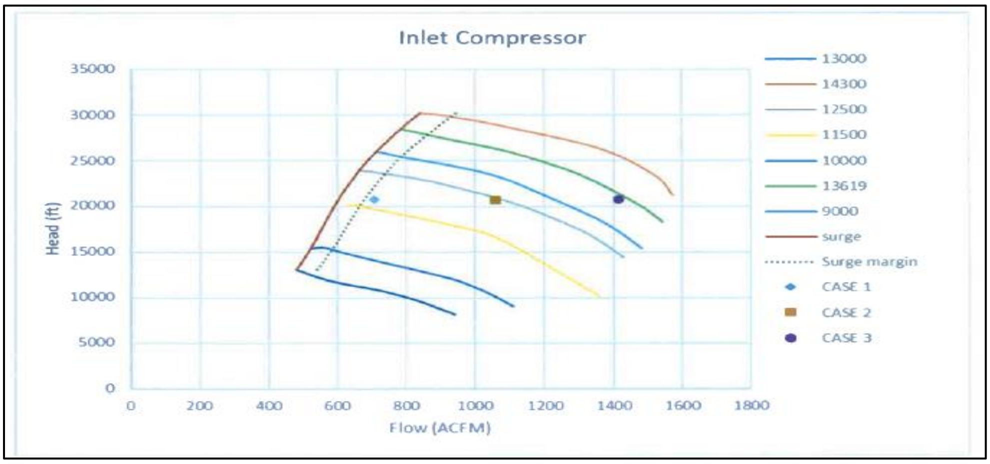

Figure 4. Compressor performances for Inlet Gas Rate

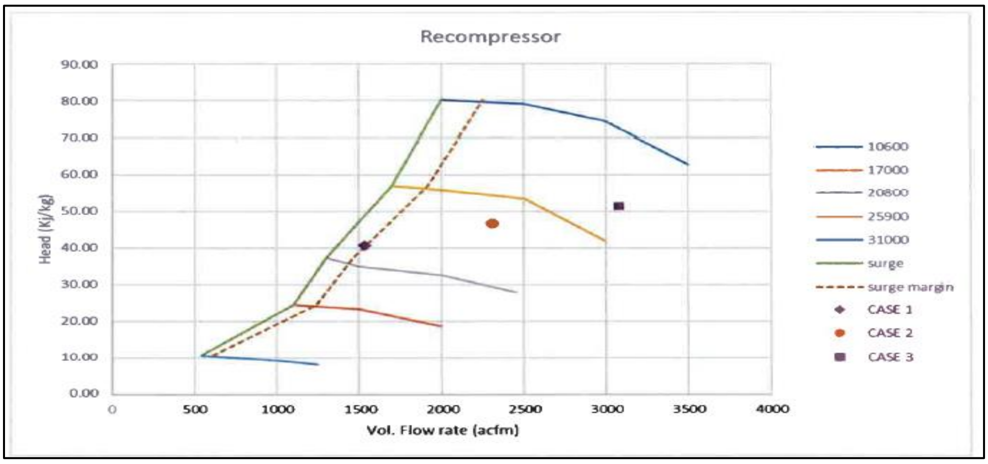

Figure 5. Comparison of turbo expander efficiency

From simulation using UNISIM software, it is concluded that compressor restaging does have positive impact on LPGF optimization with higher efficiency, higher LPG yield and better operability at low flow condition. Estimated maximum gas flowrate that can be handled at LPGF with new set up, restaged inlet gas compressor, restaged turbo expander/recompressor is 80 MMSCFD.

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3. Result and Discussion

3.1. GTC Inlet Residue Compressor Performance

Figure 6 shows the inlet compressor performance curve with flow (acmm) and head (kJ/kg) collected from Uniformance.

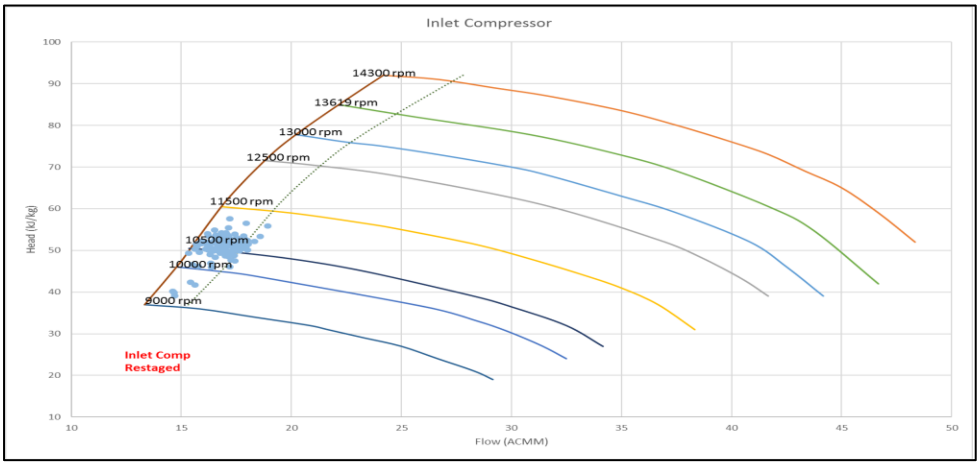

Figure 6. Inlet Compressor Performance Curve

3.2 ASV Position Taken From Uniformance

ASV position for both HP and LP compressor are 90 – 100% CLOSED, compare to before restaging when it was 60-70% closed. When both unit operated with anti-surge control valve closed, noise around the package will be lower.

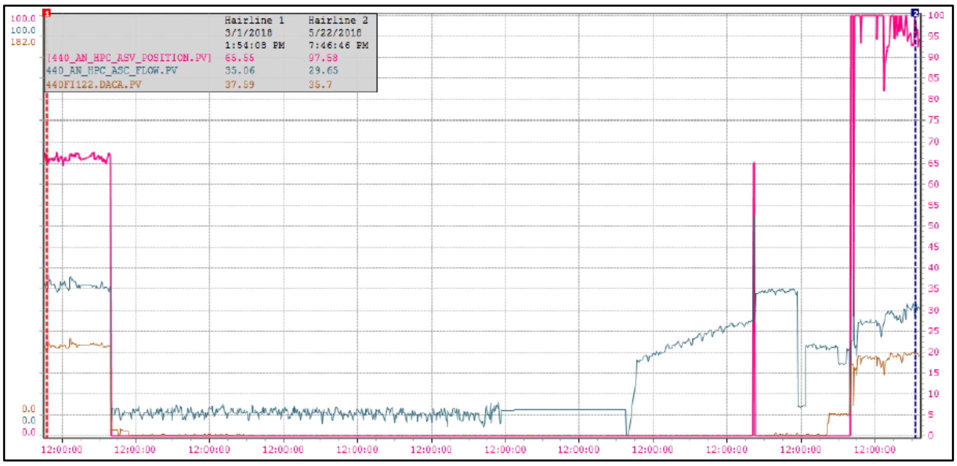

Figure 7. Anti-surge control valve position after restaged

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3.3. Fuel Gas Saving

From figure 8, there is **±42%** decrease in GTC fuel consumption from 1039 kg/h to 600 kg/h. Total fuel gas consumption after restaging decreased **±12%** from 5.9 MMscfd to 5.2 MMscfd (Figure 9)

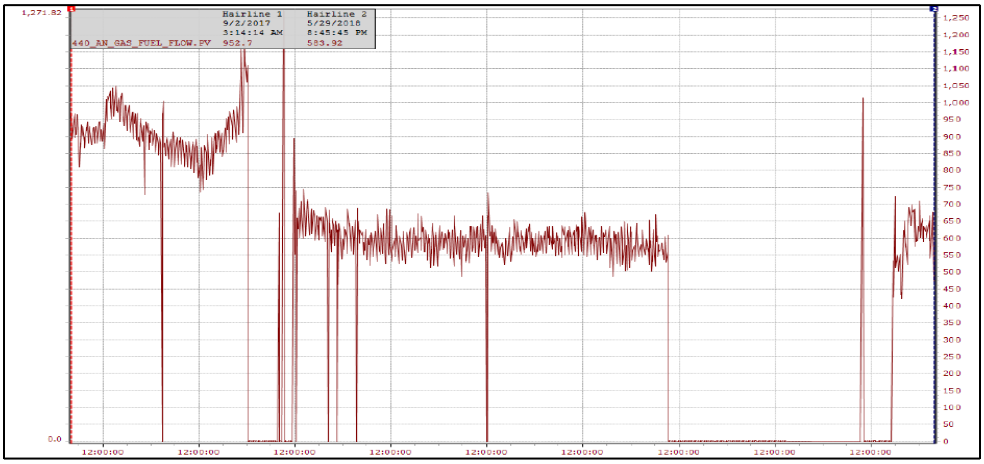

Figure 8. GTC Fuel Consumption

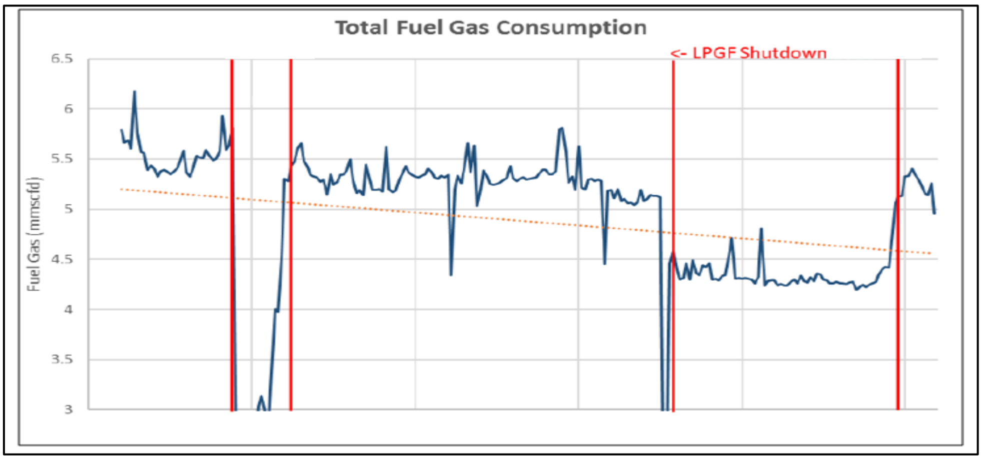

Figure 9. Fuel Consumption after Restaging

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3.4. Turbo Expander/Recompressor Performance

As shown in Figure 10, after turbo expander/recompressor restaging, discharge temperature and pressure to deethanizer can reach -78 degC and 17 barg at inlet flow 34 mmscfd.

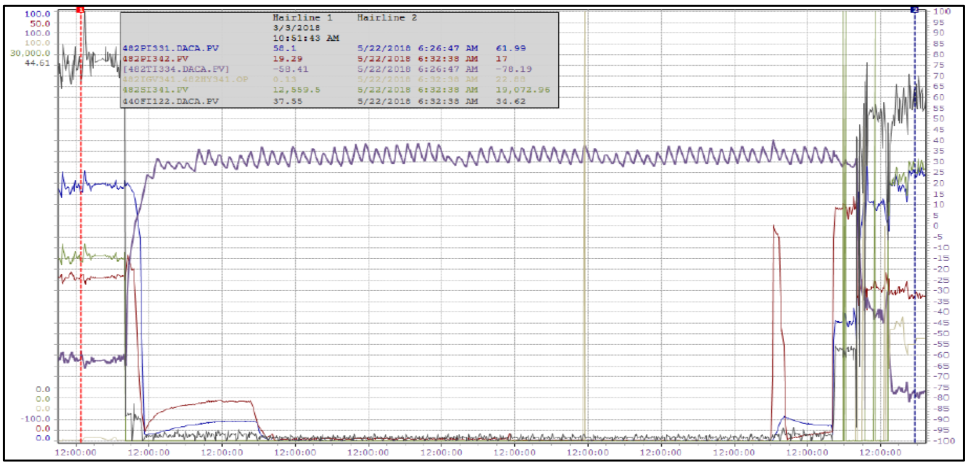

Figure 10. Turbo Expander Operating Parameter

3.5. LPG Recovery and Yield

By restaging and optimization LPG recovery will increased. There is significant increase in Propane recovery to around 85% compare to before restaging which was 60%. Table 1 and Figure 11 shows comparation of LPG recoveries before and after restaging.

Table 1. LPG Yield Before and After Restaging

	Before Restaging	**After Restaging**
Sales Gas	34 MMscfd	30 MMscfd
Propane in Sales Gas	2%	0%
Butane in Sales Gas	0.14%	0.03%
Gas Flow to LPGF	40 MMscfd	34 MMscfd
Propane Recovery	60%	85%
Butane Recovery	95%	98%
Total LPG Recovery	75%	90%
LPG Yield	32 bbl/mmscfd	40 bbl/mmscfd
GTC Fuel Consumption	1039 kg/h	600 kg/h
Total Fuel Gas Consumption	5.9 MMscfd	5.2 MMscd

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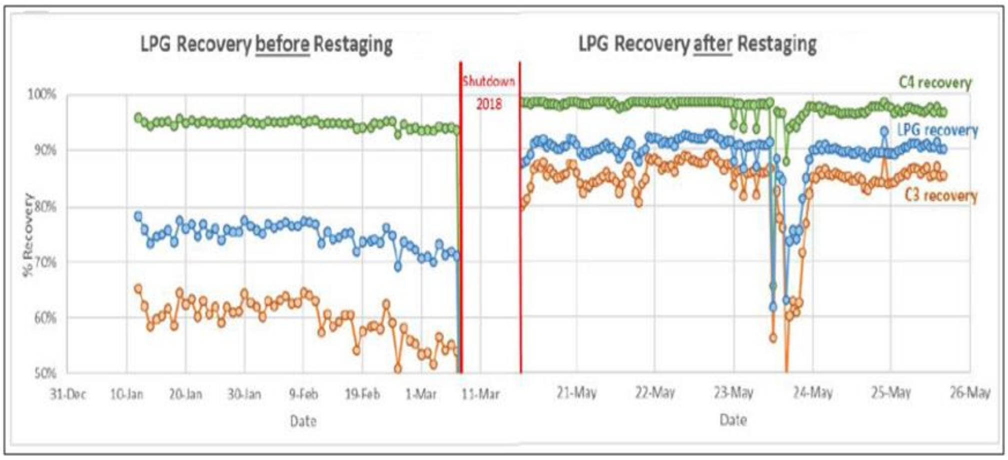

Figure 11. LPG Yield Before and After Restaging

LPG yield after restaging (data taken from Daily Production Report) is also **increase from 32 bbl/mmscf (before restaging) to 40 bbl/mmscf (after restaging)**. This yield is close to predicted value by Unisim simulation on previous engineering review.

4. Conclusion

1. After GTC Inlet Compressor (HP) restaging, the Inlet Compressor can deliver higher discharge pressure with ASV (Anti Surge Valve) in nearly closed position. This higher discharge pressure will provide bigger pressure expansion on Turbo Expander which will increase LPG recovery.

2. After GTC Residue Compressor (LP) restaging, the Residue Compressor can deliver higher discharge pressure as well and provide better margin for delivery pressure to consumer with ASV (Anti Surge Valve) in nearly closed position which provide optimum compressor performance.

3. After Turbo Expander-Recompressor restaging, discharge temperature of Turbo Expander to Deethanizer column can get cooler temperature up to – 78 deg C which significantly increase the LPG recovery from 75% to 90%. LPG yield also increase from 32 bbls/mmscf to 40 bbls/mmscf. It is expected that Turbo Expander still can be operated with lower gas rate at 20 mmscfd to keep LPGF plant running.

4. In terms of fuel gas saving, fuel consumption of GTC has been reduced by 42% from 1 mmscfd to 0.6 mmscfd, whilst a total fuel consumption decreased by 12%, from 5.9 mmscfd to 5.3 mmscfd.

5. LPGF control valves after modification and resizing show higher valve opening which provide better operating controllability.

6. Opportunity in future increase production, GTC anti-surge valve can be 100% closed and more chance for fuel gas saving.

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