MAINTAINING EXCELLENCE IN A DECLINING PRODUCTION

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ABSTRACT
PT Badak NGL operate and maintain the state owned Natural Gas Liquefaction Plant, situated in Bontang, East Kalimantan - Indonesia. In 1999, with the installation of Train H, the facilities reached its maximum capacity of 22.5 MTPA with 8 LNG Trains and 3 LNG/LPG Docks. Production quickly follows by reaching a maximum 21.4 MTPA in 2001. Since its golden year, Bontang LNG plant has endured a decade of decline in LNG Plant Production. The main target for the last decade, is to cope with plant capacity decline while at the same time maintain plant efficiency and excellent performance in all aspects. Defining the number of running trains, struggling to maintain Plant Thermal Efficiency (PTE), managing a performing workforce, being prepare for facilities to be put on long term idle/mothball, anticipating new gas sources with new characteristic are some of the problem dealt in the past decade. These efforts are paying off. Benchmark result shows that Bontang LNG Plant has one of the lowest operating cost and the lowest maintenance cost. After obtaining the ISRS 8 level 8 we are proud to say, Badak LNG Plant is the safest LNG Plant in the world. Now, with the Badak LNG Learning Center (BLC) and the dawn of a new era, we are ready to share the experience and the knowledge with the world.

BACKGROUND

PT Badak NGL (PTB) history began with the discovery of a large gas reserve in Muara Badak - East Kalimantan in 1972. PERTAMINA and its Production Sharing Contractors (PSC) namely HUFFCO (now VICO), TOTAL and UNOCAL (now CHEVRON), initiate efforts to monetize the stranded gas to Buyers in Japan. Together with JILCO, a coordination body for the Japanese buyers, the stakeholder agrees to establish a nonprofit organization which is responsible with the daily operation and maintenance of the LNG Facilities. Hence in 1974, PTB was established and Bontang, 57 km north of Muara Badak, was to be the Plant Site due to its naturally sheltered port.

After 20 years of development era, beginning with 2 LNG Trains capacity of 3.3 MPTA, numerous expansion and debottlenecking project, diversifying production (LPG), Bontang LNG Plant reached a peak of 8 LNG Trains and installed capacity of 22.5 MTPA LNG and 1.2 MTPA LPG. Production also peaked in in 2001 with 21.4 MTPA of LNG and 1.2 MTPA of LPG. Making Bontang LNG Plant, the largest single capacity facilities and production in the world.

Since its peak production in 2001, Bontang LNG Plant production has gradually decline. For a LNG plant which is very reservoir dependence, declining production is an inevitable. As reservoir depletes, LNG Production depletes. Oil Refineries can receive feed stock from external sources; some are even design to handle large variation feedstock for this purpose. LNG Plant is not as fortunate, declining Production is never attractive and as PTB found (the hard way), it is not as easy as it seems.

OBJECTIVES

This paper is aimed to exhibit the PTB’s effort of maintaining plant efficiency and excellent performance in all aspects in production declining situation. This paper also discloses some exceptional achievements have been made by PTB as the result of doing the efforts.
DEVELOPMENT

The development is started by explaining the journey of PTB journey. Second, showing the challenges how it is excellently faced. It is continued with recognition for PTB to the achievements and ended with the summary.

RESULTS

Since the beginning of PTB history began, the journey of PTB can be divided into 3 phases. They are:

1. Phase I: Building Trust
2. Phase II: Expansion and
3. Phase III: Sustainability

Each phase has its own focus which becomes the main business of the organization during the era. These can be easily illustrated to the following figure:

- **Phase I: Building Trust**

  The areas Badak Gas Field, found by Huffco Inc., in early 1972, located in East Kalimantan. Both companies are working under production sharing contracts with The State Oil Company, Pertamina. The fact that both gas areas are located very far from potential consumers whom consume natural gas in large scale. To meet the economic scale on project development, at early stage the 3 companies namely, Pertamina, Mobil Oil and Huffco agreed to develop LNG project which able to export natural gas in large quantity in liquid form. This becomes a history because the 3 companies had not have any previous experience in LNG and LNG business has never been known. It was only 4 LNG plants in the world with only 3-4 years of operational experience, it is understandable why this project was initiated by an ambitious program with little confidence for potential LNG consumers.

  Despite the above fact, painstaking months of hard work were conducted by Pertamina and it’s both partners whom tried to sell the project to two potential LNG consumers, potential financiers and also potential partners all over the world. Finally the effort was fruitful with an agreement of LNG sales contract on December 5, 1973.
The contract which then known as The 1973 Contract was containing the commitments of the buyers to import LNG from Indonesia for 20 years, to be produced and supplied by LNG plant which has not yet been fully established. On the other side, Pertamina agreed to initiate its LNG supply in mid 1977 from 2 LNG plants to be constructed within 42 months. It was a challenge. In line with the plan to establish the LNG plant, it was planned to build tanker for transportation armada and several recipient terminals, including the schedule needed to arrange the financial support for these projects.

Certainly such projects must involve many companies, banks and financial institutions and the participation from government institutions from 3 countries namely USA, Japan and Indonesia. Each country has its own discretion to bring the plant into one objective that is to ship the Indonesian LNG to Japan. It is clear that the cooperation among all parties bears an essential meaning in supporting the project to success.

In 1981, the modification was made resulted increased production capacity from its initial of 3.3 to 4.6 Million Ton Per Annum (MTPA) with same number of trains (2 trains).

- **Phase II: Expansion**

This development was continued in 1983, when 2 more trains were built which increased the capacity of LNG production from 3.3 to 9.2 MTPA. This capacity was aimed to fulfill the supply of LNG for some new sales contracts. Even more, in 1988 LPG facilities was constructed. The production diversified from only LNG to LNG and LPG productions. This was of course another triumph of PTB in expansion projects where at that time all facilities can be ready in time to meet the commitment to all stakeholders.

The success story of this phase continued with the new trains development and some excellent of existing trains modification by debottlenecking projects. Up to 1999, PTB has completely managed 8 trains facilities with capacity of 22.5 MTPA.

- **Phase III: Sustainability**

The phase is mainly showing PTB on how withstand with its existing capacity since no new trains facilities built after 1999. PTB can reach its peak production in 2001, and in this year the production and delivery become the highest among the history of the company. In after 2001 the production start to decline. The declining production indeed dictated by decreased feed supply. The conventional gas source were not able to maintain its supply capacity since mature natural gas reserve condition even efforts have been done to maintained.

The challenges start when the facilities was running with inoptimum operation since not all the production capability can be utilized. Low load factor of the trains was causing some techical issues such as plant efficiency and another issues of plant reliability which related to the aged plants. However PTB, again has shown its excellence operation by developing some effort to overcome these.

In the issues of plant efficiency, PTB defined the strategy to maintain by defining number running trains with the supplied feed gas.

During its peak production in 2001, the LNG plant was becoming one of the the largest in the world. The overall plant operation, the highest efficiency can only be achieved by running all Trains at their maximum capacities. In case of gas supply shortages, this operating mode can only be achieved by putting one LNG Train on idle position for a period of time so that the remaining running LNG Trains can be pushed to the maximum production rates. However, from gas production point of view, it is a luxury to have extra running LNG Trains to ensure a full absorption of the whole gas produced, even if one LNG Train trips during the operation. It is therefore necessary to find a compromise that satisfies both the plant operation efficiency and the production availability.
Energy Efficiency

In general, the energy balance in plant can be simplified in following figure.

It can be seen that the main stream of efficiency is feed as an input and fuel, losses, and products as an output. Meanwhile the efficiency is define as the total products per input. Therefore efficiency is dictated by how high the products as well as how low the fuel and losses.

A strategy needs to be developed to do this. The strategy covers the following major:

- Fuel gas optimization
- Gas loss prevention

The strategy is compiled in Energy Efficiency Program.

**Fuel Gas Optimization**

*Optimum number of running trains*

From the individual Train capacity, the overall plant production capacity of 7, 6, 5, and 4 LNG Trains can be shown in following figure. This figure indicates the maximum and minimum production capacity. The assumption of the highest capacities when all large Trains are in operation and the lowest capacities possible when all small Trains are in operation. Even though the plant can be operated at lower close to the minimum capacity indicated in following figure, but the refrigeration compressors will be in deep surging operating regimes and the recycle valves are opened causing the LNG Trains operating in much less efficient mode.

The era of plant operation with the gas delivery in above 2,200 MMSCFD has passed. This era was marked with the decision that the turning point to start running 5 Trains from 6 Trains operating mode was at the feed gas delivery 2,200 MMSCFD or lower. Presently, the feed gas is ranged in below of 2,200
MMSCFD and even below 1,800 MMSCFD with actual feed gas about 1,600 – 1,700 MMSCFD. The decision was made to have more efficient operation by running in 4 Trains.

The following figure is showing fuel to LNG ratio vs feed gas for 4 and 5 trains operation. Fuel to LNG ratio is the amount of fuel consumption in boilers (in Nm3) to generate steam for each LNG produced (in m3). Please note that fuel consumption comes from boil off gas and feed gas make up.

When feed gas is 1,700 MMSCFD, for example, therefore if 5 Trains to be maintained, we loss efficiency about 8 Nm3/m3 LNG compare to run in 4 Trains mode.

*Power generators management*

This effort is made by putting the optimum number of power generators in operation. This is done with consideration of maintaining electrical supply with optimum load of power generator which in PTB is about 8 - 9 MW of 12.5 MW maximum capacity. The number has accommodated swing capacity in the generators.

By this operation mode, it is expected that the steam consumption for each power generated will be optimum. Optimum steam consumption means optimum fuel consumption to generate steam as well.

- **Gas Loss Prevention**

  *Flare Gas Recovery Project*

  This project is based on the fact that the flared gas from the process area of LNG plant is a main contributor of the losses. Especially during abnormal where the excessive gas should be flared, the losses will become significantly increase. Therefore, this project is intended to recover the gas that in current condition is flared to be recover as fuel gas. This project is expected to give gain of 0.1 MMSCFD.

  *Liquid HC Recovery Project*

  This project is actually similar with the previous one, as the losses but come from liquid form will be recovered. This project is expected to give gain of 0.1 MMSCFD.

*Fuel Balance Optimization*

The balance of fuel gas system as shown in following figure is determined by the amount of fuel gas supply and fuel gas consumption. The main supply, in ideal condition, should be fulfilled by gas generated from process and tanks otherwise in condition of lack of supply, make up will be the solution. However in an unfortunate condition, the normal supply without make up is exceeding the consumption. In this condition, there will be excessive supply and lead to fuel gas venting (loss). Therefore, anticipation is aimed to reduce this excessive fuel gas supply such lowering LNG temperature, improve fuel gas make up control and try to recover off gas to feed gas.
**Toward Zero LPG Flaring**

The project is to minimize and eliminate LPG flaring. The program is done by following program:

- LPG vapor flow rate control from transfer line
- To utilize Dock-2 for LPG loading
- To subcool the high pressure Propane saturated liquid from LPG Reliquefaction Plant using coolbox in LPG Refrigeration Plant (Plant 15)
- To install the second LPG Reliquefaction System (long term effort)

**Long Term Idle**

Based on the future feed gas forecast, PTB will not require to operate all 8 Trains starting. There will be excess Trains. However based on recent new feed gas field development, the feed gas is potential to recover in the future. Hence one or more Trains will be required in the future. Therefore PTB needs to put one of the Train in Long Term Idle position starting in 2013 and develop preservation manual for the Train.

A Train put on Long Term Idle is a Train that according to the gas delivery forecast will be required to be put back in service sometimes in the future to meet the gas delivery forecast. Preservation will be applied. Manpower will have to be recruited and trained before re-commissioning of the Train. The reactivation requires less than 2 year (preparing manpower).

The purpose of the this preservation is:

- To maintain plant mechanical integrity
- To minimize time requirement for re-activation
- To decide and optimize the idle equipment that should be preserved
- To identify the problem that may be occured during idle conditions.

**Anticipating New Gas Sources**

In 2001, after more than 25 years of increasing Production (1977-2001), the Mahakam reached its peak as the fields are becoming mature. In 2001, Badak LNG Plant processed on average 3,297 MMSCFD of gas. Since then the feed gas production from the mature field is steadily decreasing. This steady decrease will continue in the following decades. Therefore the question is raised how to maintain the sustainability of the Badak LNG Plant which still have a long Remaining Useful Life.

In order to sustain the Badak LNG Plant, it is anticipated that additional conventional gas sources will be put in production in the coming years i.e. New Field no. 1 and New Field no. 2. Indonesia is known to have very significant reserves of Coal Bed Methane (CBM – unconventional gas) and Badak LNG Plant/Bontang (East Kalimantan) is ideally located in an area with a very high CBM Potential. Therefore CBM could be in the future a major source of feed gas for Badak LNG Plant to maintain the current LNG Plant sustainability.
Compared to the existing feed gas quality on which the LNG Plant has been designed, the future gas sources from Field no. 1, Field no. 2 and CBM will be very lean (especially CBM – almost pure Methane). Consequently these future new gas sources will have an impact on the Plant performances i.e. Plant Overall Production Limitation, Plant bottlenecks and LNG specification. Consequently this impact must be assessed to indentify all the studies that will have to be done to identify, design, engineer and implement all the modifications that will be required to process efficiently these future gas sources, deliver on specification LNG and be ready on time when those gas sources will be delivered to Badak LNG Plant.

Badak LNG Plant is currently conducting a study to assess the potential impact on the Plant performances of processing Leaner Gas Sources. For this study, Badak LNG Plant has considered the following Lean Feed Gas Sources:

1) Field no. 1 lean gas (starting 2013)
2) Field no. 2 project Lean gas (starting 2015)
3) Assumed high CBM delivery leading to a full utilization of the Badak LNG Plant starting 2019 with a ramp-up from 2016 to 2019

Besides the high Methane content of the CBM, another component that may have a significant impact on the LNG Plant and LNG specification is Nitrogen. Compared to the “Conventional” feed gas streams on which the LNG Plant has been designed (“heavy” feed gas), the future Lean Gas Sources are characterized by a higher Methane content (of course), a higher Nitrogen content (hypothesis considered for CBM), a much lower CO₂ content (good for the Acid Gas Removal Plant and green house gases emissions) and a much lower Ethane, Propane and Butane content (potential problems to generate refrigerant make-ups such as Ethane and Propane). The figure below gives over the time the trending of the estimated feed gas composition component by component.

**LNG Benchmarking**

Latest LNG Benchmark result in 2012 discovered (again) that PTB is the best among other LNG plants in the world by demonstrate best performance in several categories. The summary of the benchmarking result for each category is as follow:

- **Safety Health & Environment**  
  1st best, with zero Lost Time Injuries (LTIs) since 2006

- **Reliability**  
  1st best, with 99.2% Plant Reliability achievement

- **Operating Cost**  
  1st best, with lowest Unit Operating Cost
- Maintenance Cost
  1st best, with lowest Maintenance Cost
- Personnel
  2nd best, with 2nd lowest Personnel cost

**ISRS 8 level 8**

ISRS is International Sustainability Rating System. It is a system for assessing, improving and demonstrating the health of organization’s business processes. PTB has implemented this assessment tool since 2006, and up to 2012 the excellence result has been granted. Since 2009, PTB has reached extraordinary achievement of Level 8 in ISRS. The other remarkable from this achievement is that PTB is the first and the only Oil & Gas Company awarded level 8, worldwide. Hence PTB is stated as a reference of World Class Companies.

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**Badak LNG Learning Center (BLC) and Operations and Maintenance Services (O&M)**

The BLC and the O&M Services will be the gateway for PTB to share almost 40 years LNG business experience with our valued customers.

- Badak LNG Learning Center (BLC)
  The BLC has successfully provided many international companies in their need to prepare capable operators, maintenance technicians, safety officers, emergency and rescue response personals, laboratory technicians and other key positions to operate and maintain LNG Plant. Badak LNG Learning Center offers a wide variety of trainings to custom fit customers need.

  BLC provides high quality learning programs to generate professionals in operating and maintaining LNG Plant. Through our learning program we aim to generate:

  1. Professional Plant Operator
  2. Highly skilled Maintenance Technician with hands on experience
  3. Fire Brigade and Emergency Response Personnel trained to deal with hydrocarbon and LNG fires as well as performing rescue and evacuation techniques.
  4. Laboratory Technician and Analyst who are responsible for product and process quality control in accordance to standards procedures.
  5. Production Controller able to perform production planning, shipment scheduling, custody measurement and calculation.
• **Badak LNG O&M Services**

The O&M Services provide qualified expert, highly skilled and competent workforce to operate and maintain LNG Plants. Experience operators are ready to commission, start up and operate LNG Plants. Skilled and competent maintenance workforce is ready to handle preventive maintenance, predictive maintenance and turnaround for LNG Plants. PTB strive to maintain excellent relationships with our clients by continuously improving first class trainings and O&M service programs.

The Operation and Maintenance Services is supported by PTB experience in LNG plant operation and maintenance for almost 40 years. PTB employees are qualified expert, highly skilled and competent workforce. PTB also achieved certification of ISO 9001, ISO 14001, ISO 17025 and Level 8 of isrs8. BLC provides customized Operation & Maintenance Services for LNG Plant, tailor fit for client needs.

Badak LNG Learning Center has successfully assisted the commissioning and start-up of LNG Plant of several companies.

**SUMMARY**

- The challenges of PTB in declining production start when the facilities was running with inoptimum operation.
- PTB maintains plant efficiency by develop program for fuel gas optimization and gas loss prevention
- Long Term Idle program is implemented to anticipate the excessive Trains in the future
- Anticipating new gas sources is done by conduct study to sustain the Badak LNG Plant
- PTB has been recognized worldwide by significant result of LNG benchmarking and ISRS assessment
- The BLC and the O&M Services is the excellence way of PTB to share almost 40 years LNG business experience