# Evaluation of Production Capability Using The Min-Max Stock Method: A Case Study at An Indonesian Oil Refinery Unit

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**Abstract.** The availability of tanks in production activities greatly influences production capabilities in a processing oil company. Tanks must not be filled with products so that production activities are not disrupted. So, evaluation is needed in production activities to maintain smooth production and determine the tank's production capabilities. This research uses the min-max stock method to determine the effect of tank capacity on monthly production capability, minimum stock, maximum stock, and ullage value of Perta series products. Results for Pertalite products, namely monthly production capacity of 2,291.40 MB, minimum stock of 309.48 MB, maximum stock of 500.43 MB, and a tank ullage value of 3.53 days. Meanwhile, for Pertamax products, the monthly production capacity is 401.40 MB, minimum stock of 96.70 MB, maximum stock of 123.46 MB, and tank ullage value of 4.97 days.

**Keywords:** Production Capability, Maximum Stock, Min-Max Stock, Minimum Stock, Ullage.

## 1 Introduction

A company's production capability is significant in determining a business's success and continuity [1]. Production capability evaluation is a step in identifying the extent to which an entity can produce goods or services. By analyzing and measuring production capabilities, companies can take steps to overcome production obstacles [1], [2].

RU IV is one of the downstream processing sectors owned by a State-Owned Enterprise company. RU IV focuses on processing crude oil produced from upstream operations. Its products are distributed to the broader community. One of the products produced from the processing process is the Perta series, namely Pertalite and Pertamax. It shows that product processing must be adjusted to meet people's needs.
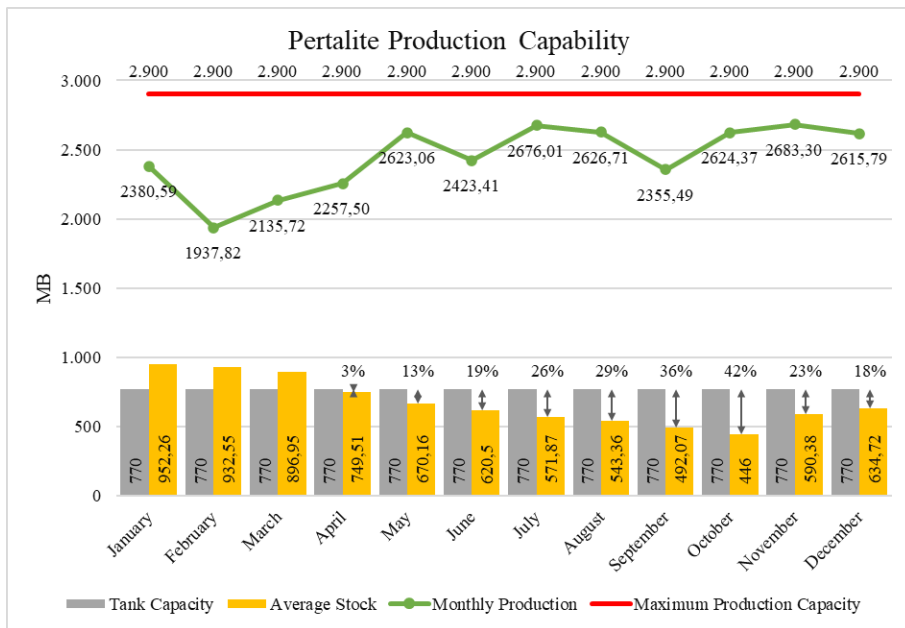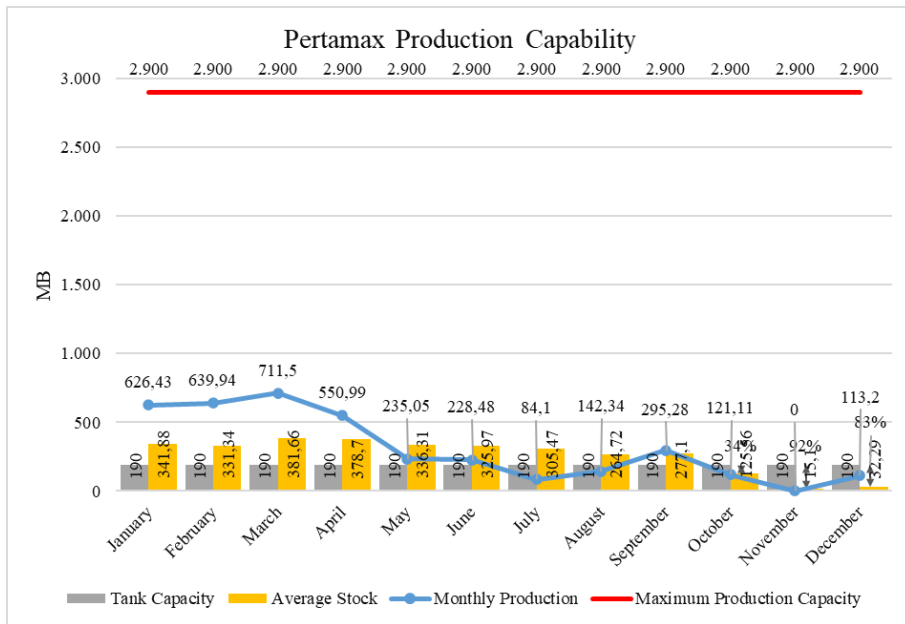
**Fig. 1.** Actual Pertalite in 2022.



**Fig. 2.** Actual Pertamax in 2022.

The availability and use of tanks in RU IV's production process significantly impact production capabilities. Tanks are used according to availability and need to be regularly repaired, which can reduce the number of tanks available. There are also spare tanks used to

replace tanks being repaired or as additional ones if needed to process larger quantities of product. It is essential to comply with the rules that dictate that the tank is not filled (maximum 65% capacity) with the remainder as ullage, which is the space in the tank.

Tanks available for production and product storage must be adequately managed to avoid disruption in production activities [3], [4]. Based on Fig. 1 and Fig. 2, the Perta series product stock for 2022 shows violations of storage rules that could disrupt production. Efficient management and careful maintenance of tanks is essential to maintain smooth production [5], [6].

## 2    Methodology

Several steps are taken in preparing a practical work report [7]. This stage is carried out to facilitate the implementation of practical work and produce an excellent final report. The research methodology used can be seen in Fig. 3.
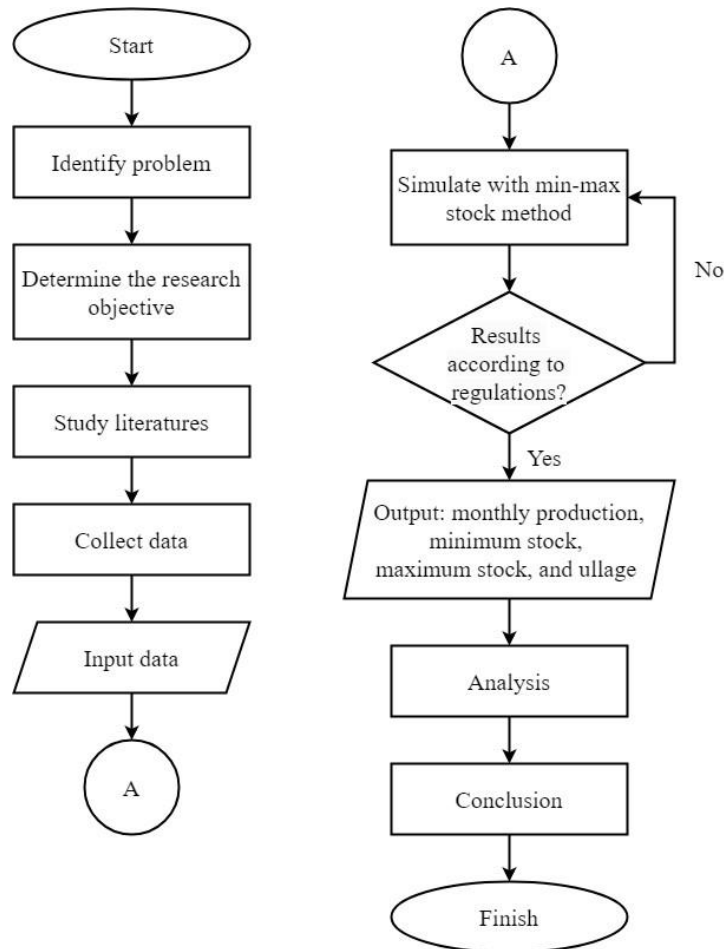


**Fig. 3.** Research Flow.

## 2.1 Ullages

Ullage is the space in a tank that is not filled with liquid and is measured from the liquid surface to the tank surface [4]. Ullage has an essential role in storage tank management and fluid transportation. Its function includes measuring the volume of liquid remaining in the tank, which helps control the liquid supply and ensures that the tank is not too full or too empty, which can cause operational and safety problems [3]. Tank ullage is also an essential factor in planning the distribution and transportation of liquids, as it calculates the volume of ullage required to store liquids safely and efficiently [3], [4].

## 2.2 Min-Max Stock Method

The min-max stock method determines the minimum and maximum amount of inventory by controlling the ordering of goods to avoid running out or excess stock [8]. The basic idea of this method is to maintain a minimum inventory to replace damaged goods but not to exceed the maximum limit to avoid high costs [9], [10].

The steps and mathematical equations for the min-max stock method used in inventory control are [11]–[13]:

**Determination of Safety Stock.** Safety stock is the amount of additional inventory placed as a reserve in anticipation of potential raw material shortages due to usage exceeding the initial estimate.

$$SS = z \times Sd \times \sqrt{LT} \tag{1}$$

Information:

| | |
|---|---|
| z | = Service factors |
| Sd | = Standard deviation |
| LT | = Leadstime |
| SS | = Safety stock |

**Determination of Minimum Stock.** Minimum stock is the lowest amount of inventory that must be maintained during the purchase order period, which is calculated by multiplying the order duration by the average usage in a certain period (month/week/day) and then adding it to the safety stock. In this study, lead time is in days. The equation used to determine minimum stock is:

$$Minimum\ Stock = (T \times LT) + SS \tag{2}$$

Information:
| | |
|---|---|
| Q | = Average demand |
| LT | = Leadstime |
| SS | = Safety stock |

**Determination of Maximum Stock.** Maximum inventory is the maximum amount of inventory a company holds to prevent losses due to high costs associated with excessive inventory. The equation used to determine maximum stock is:

$$Maximum\ Stock = 2 \times (T \times LT) + S \tag{3}$$

Information:
Q      = Average demand
LT     = Leadstime
SS     = Safety stock

**Determination of Order Quantity.** Order quantity is the number of products ordered when inventory reaches the order point. The equation used to determine the number of orders is:

$$Q = 2 \times T \times LT \tag{4}$$

Information:
Q      = Average demand
LT     = Leadstime

**Reorder Point Determination.** Reorder Point (ROP) is the inventory level at which an order must be redone. The equation used in determining ROP is:

$$ROP = (T \times LT) + SS \tag{5}$$

Information:
Q      = Average demand
LT     = Leadstime
SS     = Safety stock

# 3    Results and Discussion

## 3.1  Tank Data

Data on the tanks used to produce and store Perta series products can be seen in Table 1 and Table 2.

**Table 1:** Pertalite Tank Data

| Product | Tank | Capacity (MB) |
|---------|------|---------------|
|         | 36T-101 | 200 |
|         | 36T-103 | 200 |
| Pertalite | 36T-105 | 200 |
|         | 31T-1 | 70 |
|         | 32T-105 | 100 |
| Total   |      | 770 |

(Source: Secondary Data from RU IV, 2023)

**Table 2:** Pertamax Tank Data

| Product | Tank | Capacity (MB) |
|---------|------|---------------|
| Pertamax | 32T-104 | 120 |

| | |
|---|---|
| 31T-2 | 70 |
| Total | 190 |

## 3.2 Lead Time Data

Lead time, namely the time used to produce, starts from distributing raw materials until the product is ready to be distributed and sold [12], [14]. Lead time data in producing Perta series products can be seen in Table 3.

**Table 3:** Lead Time Data.

| Product | *Lead Time* |
|---|---|
| Pertalite | 2.5 days |
| Pertamax | Two days |

## 3.3 Service Level Values and Optimal Tank Capacity

Service level shows the company's ability to meet needs with a service level of 95%. The optimal tank capacity is 65% of the total capacity to maintain smooth production when the product cannot be removed.

## 3.4 Simulation of Pertalite Product Production

**Pertalite Base Case (Total Tank Capacity 770 MB).** In this base case, five tanks are available for production, with a total tank capacity of 770 MB. Pertalite tank for the base case can be seen in Table 4.

**Table 4:** Pertalite Tank Data (Base Case).

| Product | Tank | Capacity (MB) |
|---|---|---|
| | 36T-101 | 200 |
| | 36T-103 | 200 |
| Pertalite | 36T-105 | 200 |
| | 31T-1 | 70 |
| | 32T-105 | 100 |
| Total | | 770 |

Calculation:

| | | |
|---|---|---|
| *Total of tank capacity* | = | *770 MB* |
| *Production average* | = | *76,38 MB* |
| *Deviation Standard* | = | *45,58 MB* |
| *Service level* | = | *95%* |

| | | |
|---|---|---|
| Service factor | = | 1,64 |
| Lead time | = | 2,5 days |
| Safety stock | = | 118,53 MB |
| Maximum stock | = | 500,43 MB |
| Minimum stock | = | 309,48 MB |
| Optimal tank capacity | = | 64,99% |
| Ullage | = | 3,53 days |
| Total of production | = | 2291,4 MB |

**Case 1 Pertalite (Total Tank Capacity 700 MB).** In case 1, 4 production tanks are available, but one tank with a capacity of 70 MB is removed (highlighted in yellow), so the total available tank capacity is 700 MB. Pertalite tank for case 1 can be seen in Table 5.

**Table 5:** Pertalite Tank Data (Case 1).

| Product | Tank | Capacity (MB) |
|---|---|---|
| | 36T-101 | 200 |
| | 36T-103 | 200 |
| Pertalite | 36T-105 | 200 |
| | 31T-1 | 70 |
| | 32T-105 | 100 |
| Total | | 700 |

Calculation:

| | | |
|---|---|---|
| Total of tank capacity | = | 700 MB |
| Production average | = | 67,28 MB |
| Deviation Standard | = | 45,58 MB |
| Service level | = | 95% |
| Service factor | = | 1,64 |
| Lead time | = | 2,5 days |
| Safety stock | = | 118,53 MB |
| Maximum stock | = | 454,93 MB |
| Minimum stock | = | 286,73 MB |
| Optimal tank capacity | = | 64,99% |
| Ullage | = | 3,64 days |
| Total of production | = | 2018,4 MB |

**Case 2 Pertalite (Total Tank Capacity 700 MB).** In case 2, there are three tanks available for the production process. There is a reduction of 2 tanks, namely a 70 MB capacity tank and a 100 MB capacity tank (highlighted in yellow). The total available tank capacity is 600 MB. Pertalite tank for case 2 can be seen in Table 6.

**Table 6:** Pertalite Tank Data (Case 2).

| Product | Tank | Capacity (MB) |
|---|---|---|

| | | |
|---|---|---|
| | 36T-101 | 200 |
| | 36T-103 | 200 |
| Pertalite | 36T-105 | 200 |
| | 31T-1 | 70 |
| | 32T-105 | 100 |
| Total | | 600 |

Calculation:

| | | |
|---|---|---|
| *Total of tank capacity* | *=* | *600 MB* |
| *Production average* | *=* | *54,28 MB* |
| *Deviation Standard* | *=* | *45,58 MB* |
| *Service level* | *=* | *95%* |
| *Service factor* | *=* | *1,64* |
| *Lead time* | *=* | *2,5 days* |
| *Safety stock* | *=* | *118,53 MB* |
| *Maximum stock* | *=* | *389,93 MB* |
| *Minimum stock* | *=* | *254,23 MB* |
| *Optimal tank capacity* | *=* | *64,99%* |
| *Ullage* | *=* | *3,87 days* |
| *Total of production* | *=* | *1628,4 MB* |

**Case 3 Pertalite (Total Tank Capacity 700 MB).** In case 3, there are four production tanks, 2 of which are reduced (70 MB and 100 MB), highlighted in yellow, and one holding tank (200 MB) is added (highlighted in blue), so the total available tank capacity is 800 MB. Pertalite tank for case 3 can be seen in Table 7.

**Table 7:** Pertalite Tank Data (Case 3).

| Product | Tank | Capacity (MB) |
|---|---|---|
| | 36T-101 | 200 |
| | 36T-103 | 200 |
| Pertalite | 36T-105 | 200 |
| | 31T-1 | 70 |
| | 32T-105 | 100 |
| | Container | 200 |
| Total | | 800 |

Calculation:

| | | |
|---|---|---|
| *Total of tank capacity* | *=* | *800 MB* |
| *Production average* | *=* | *80,28 MB* |
| *Deviation Standard* | *=* | *45,58 MB* |
| *Service level* | *=* | *95%* |

| | | |
|---|---|---|
| Service factor | = | 1,64 |
| Lead time | = | 2,5 days |
| Safety stock | = | 118,53 MB |
| Maximum stock | = | 519,93 MB |
| Minimum stock | = | 319,23 MB |
| Optimal tank capacity | = | 64,99% |
| Ullage | = | 3,49 days |
| Total of production | = | 2408,4 MB |

Based on the simulation, an analysis of the results obtained is then carried out. The simulation results of Pertalite products can be seen in Fig. 4.
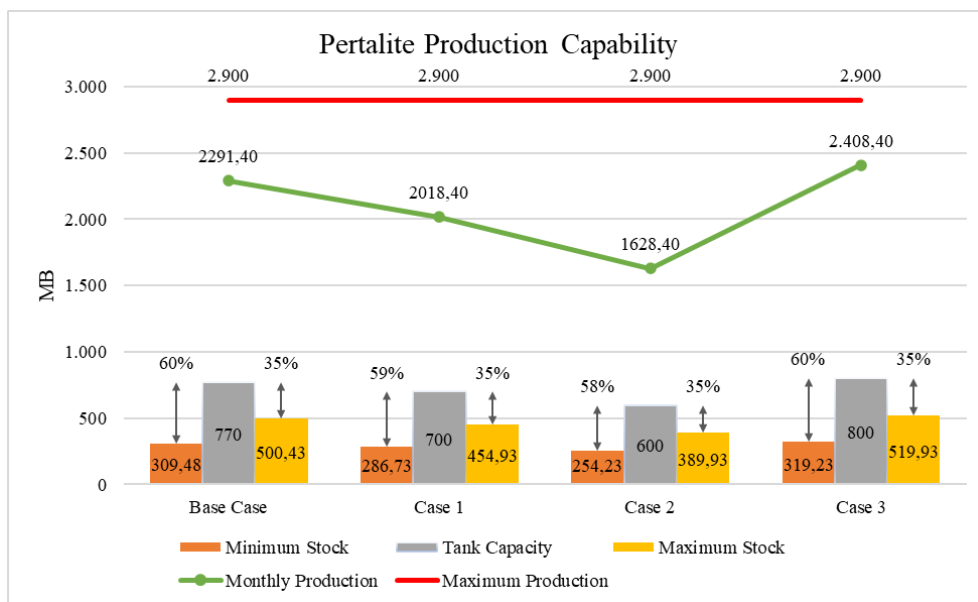


**Fig. 4.** Pertalite Production Capability Graph.

Based on Fig. 4, it can be concluded that in all cases, monthly production capabilities are below the maximum monthly production capacity, so the simulation results follow the specified production capabilities. Based on this simulation, the ullage values obtained for each tank capacity condition can be seen in Table 8.

**Table 8:** Ullage Value of Pertalite Products

| Cases | Ullage(MB) | Ullage(Day) |
|---|---|---|
| *Base Case*(770 MB) | 269.57 | 3.53 |
| *Cases*1 (700MB) | 245.07 | 3.64 |
| *Cases*2 (600MB) | 210.07 | 3.87 |
| *Cases*3 (800 MB) | 280.07 | 3.49 |

## 3.5 Simulation of Pertamax Product Production

**Pertamax Base Case (Total Tank Capacity 190 MB).** In this base case, two tanks are available for production, with a total tank capacity of 190 MB. The Pertamax tank for the base case can be seen in Table 9.

**Table 9:** Pertamax Tank Data (Base Case).

| Product | Tank | Capacity (MB) |
|---|---|---|
| Pertamax | 32T-104 | 120 |
| | 31T-2 | 70 |
| Total | | 190 |

Calculation:

| | | |
|---|---|---|
| *Total of tank capacity* | = | *190 MB* |
| *Production average* | = | *13,38 MB* |
| *Deviation Standard* | = | *30,07 MB* |
| *Service level* | = | *95%* |
| *Service factor* | = | *1,64* |
| *Lead time* | = | *2 days* |
| *Safety stock* | = | *69,94 MB* |
| *Maximum stock* | = | *123,46 MB* |
| *Minimum stock* | = | *96,70 MB* |
| *Optimal tank capacity* | = | *64,98%* |
| *Ullage* | = | *4,97 days* |
| *Total of production* | = | *401,4 MB* |

**Case 1 Pertamax (Total Tank Capacity 220 MB).** In case 1, there are two production tanks, and one 70 MB capacity tank is replaced with a 100 MB capacity tank, so the total available tank capacity is 220 MB. The Pertamax tank for case 1 can be seen in Table 10.

**Table 10:** Pertamax Tank Data (Case 1).

| Product | Tank | Capacity (MB) |
|---------|------|---------------|
| Pertamax | 32T-104 | 120 |
| | 31T-2 | 70 |
| | Container | 100 |
| Total | | 220 |

Calculation:

| | | |
|---|---|---|
| Total of tank capacity | = | 220 MB |
| Production average | = | 18,26 MB |
| Deviation Standard | = | 30,07 |
| Service level | = | 95% |
| Service factor | = | 1,64 |
| Lead time | = | 2 days |
| Safety stock | = | 69,94 MB |
| Maximum stock | = | 142,98 MB |
| Minimum stock | = | 106,46 MB |
| Optimal tank capacity | = | 64,98% |
| Ullage | = | 4,22 days |
| Total of production | = | 547,8 MB |

**Case 2 Pertamax (Total Tank Capacity 320 MB).** In case 2, there are two production tanks, and one 70 MB capacity tank is replaced with a 200 MB capacity tank, so the total available tank capacity is 320 MB. The Pertamax tank for case 2 can be seen in Table 11.

**Table 11:** Pertamax Tank Data (Case 2).

| Product | Tank | Capacity (MB) |
|---------|------|---------------|
| Pertamax | 32T-104 | 120 |
| | 31T-2 | 70 |
| | Container | 200 |
| Total | | 320 |

Calculation:

| | | |
|---|---|---|
| Total of tank capacity | = | 320 MB |
| Production average | = | 34,51 MB |
| Deviation Standard | = | 30,07 |
| Service level | = | 95% |
| Service factor | = | 1,64 |
| Lead time | = | 2 days |
| Safety stock | = | 69,94 MB |
| Maximum stock | = | 207,98 MB |
| Minimum stock | = | 138,96 MB |

| Optimal tank capacity | = | 64,99% |
| Ullage | = | 3,25 days |
| Total of production | = | 1035,3 MB |

**Case 3 Pertamax (Total Tank Capacity 800 MB).** In case 3, there is only one production tank, while the other two tanks (capacities 120 MB and 70 MB) are not used and are replaced with storage tanks with a capacity of 800 MB, so the total available tank capacity is 800 MB. The Pertamax tank for case 3 can be seen in Table 12.

**Table 12:** Pertamax Tank Data (Case 3).

| Product | Tank | Capacity (MB) |
|---------|------|---------------|
| | 32T-104 | 120 |
| Pertamax | 31T-2 | 70 |
| | Container | 800 |
| Total | | 800 |

Calculation:

| Total of tank capacity | = | 800 MB |
| Production average | = | 100 MB |
| Deviation Standard | = | 30,07 |
| Service level | = | 95% |
| Service factor | = | 1,64 |
| Lead time | = | 2 days |
| Safety stock | = | 69,94 MB |
| Maximum stock | = | 469,94 MB |
| Minimum stock | = | 269,94 MB |
| Optimal tank capacity | = | 58,74 % |
| Ullage | = | 3,3 days |
| Total of production | = | 3000 MB |

Based on the simulation, an analysis of the results obtained is then carried out. The simulation results of Pertamax products can be seen in Fig. 5.
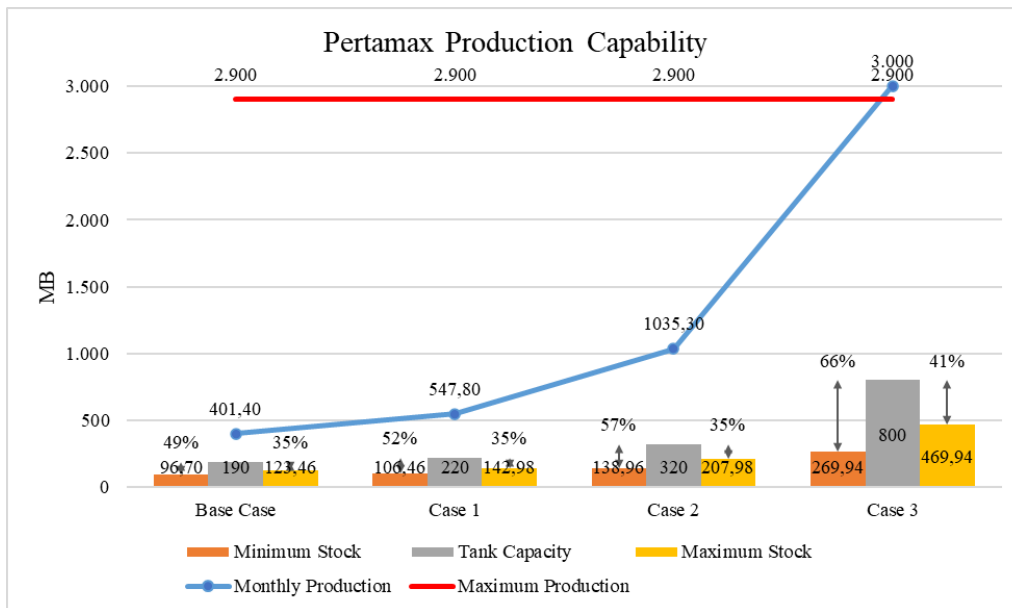
**Fig. 5.** Pertamax Production Capability Graph.

In the base cases, case 1 and case 2, the monthly production capacity is below the maximum monthly production capacity, according to the tank capacity. In case 3, even though the monthly production capability exceeds the maximum capacity, the excess production remains below 5%, within tolerance. It shows that in case 3, all tanks are used to produce and store one Pertamax product. The ullage values based on simulation results for each tank capacity condition can be seen in Table 13.

**Table 13:** Ullage Value of Pertamax Products.

| Cases | Ullage (MB) | Ullage (Day) |
|---|---|---|
| Base Case (190MB) | 66.54 | 4.97 |
| Case 1 (220MB) | 77.02 | 4.22 |
| Case 2 (320MB) | 112.02 | 3.25 |
| Case 3 (800MB) | 330.06 | 3.30 |

This research aligns with previous research by [15], which shows that distribution levels influence inventory levels, with high distribution levels resulting in more extensive maximum and minimum inventories. It also supports research findings [8], emphasizing safety stock calculations in determining inventory to avoid out-of-stock and excess inventory. Other research [8] highlights the importance of measuring tank ullage in managing space in the tank, which influences the course of production activities. Several previous researches are also in line with the results of this study [9], [10], [16].

It is hoped that the results of this research can help companies determine production quantities based on existing refinery capacity and ensure supplies comply with regulations, including

paying attention to safety stock to avoid problems with out-of-stock or excess inventory. In conclusion, safety stock and ullage values are very influential in managing a company's inventory and production and must be paid attention to maintain a smooth production process.

# 4    Conclusion

Based on the simulation that was carried out using the min-max stock method, the results of monthly production capability, minimum stock, and maximum stock of the products Perta Series are obtained. The following is the effect of total tank capacity on the results obtained:

a.   Pertalite products have a monthly production capacity of one month for a base case of 2,291.40MB with average daily production of 76.38 MB, case 1 is 2,018.40MB with average daily production of 67.28 MB, case 2 is 1,628.40MB with average daily production of 54.28 MB, and case 3 of 2,408.40MB with average daily production of 80.28 MB. The minimum stock that must be provided for the base case is 309.48 MB, case 1 of 286.73 MB, case 2 of 254.23 MB, and case 3 of 319.23MB. Meanwhile, the maximum stock that can be stored for the base case is 500.43 MB, case 1 of 454.93 MB, case 2 of 389.93 MB, and case 3 of 195.93MB.

b.   Pertamax product's monthly production capacity for the base case is 401.40MB with an average daily production of 13.38 MB, and case 1 is 547.80MB with an average production per day of 18.26 MB, case 2 of 1035.30MB with an average daily production of 34.51 MB, and case 3 of 3,000MB with an average production per day of 100 MB. The minimum stock that must be provided for the base case is 96.70 MB, case 1 of 106.46MB, case 2 of 138.96MB, and case 3 of 269.94MB. Meanwhile, the maximum stock that can be stored for the base case is 123.46 MB, case 1 of 142.98 MB, case 2 of 207.98 MB, and case 3 of 469.94MB.

Based on the simulation carried out, the tank ullage of the Perta series products is obtained for each tank change situation. For the Pertalite product, the tank ullage for the base case was 3.53 days, case 1 was 3.64 days, case 2 was 3.87 days, and case 3 was 3.49 days. For Pertamax products, the tank ullage for the base case is 4.97 days, case 1 is 4.22 days, case 2 is 3.25 days, and case 3 is 3.30 days.

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