Impact Analysis of Oversize Cylinder Liner on Piston Ring and Surging for Main Engine

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Abstract—Cylindrical liner is the place of burning to generate power or effort inside the Mother Machine. The size of the oversized diameter will affect the incomplete combustion. The purpose of this study was to determine the causes of broken piston rings and surging, the impact of oversized liners and strategies to minimize the impact of oversized cylinder liners. The research method used is SWOT analysis and questionnaire method distributed to 51 samples of students officer of ATT II class and on board interview. Oversized cylinder liner causes the piston ring to be broken and incomplete combustion causing surging turbocharger. Strategies to minimize the impact of oversized liner by replacing piston rings and cylinder liner, cleaning scavenging of water thrunk and piston groove for normal rinse air pressure and combustion quality increases

Index Terms—cylinder liner, piston ring, SWOT.

I. INTRODUCTION

There are three main elements when optimizing the performance of Internal Combustion (IC) engines in terms of improved energy efficiency [1]. First, it is important to reduce the thermal loss, which accounts for 50-60% of all losses. Second, friction losses on piston-cylinder systems, valves and engine bearings represent 15-20% of all gross losses. Almost 45% of these losses can be attributed to the cylinder system, 30-45% of which are caused by the piston ring. The oversized cylinder liner exceeds the maximum tolerance limit leading to compression and burnout escape. So much dirt that come burn and clog the groove so that piston ring jam and broken. Incomplete combustion causes unstable flue gas so turbocharger rotation goes up and surges. This study aims to analyze strategies to minimize the impact of oversized cylinder liner of Main Engine.

II. PLACE AND TIME OF RESEARCH

The study was conducted for more than twelve months starting from December 13th, 2015 to January 4th, 2017. The study was conducted on board the MT. ONTARI, a type of product oil tanker owned by PT. Gemilang Bina Lintas Tirta.

In this research is given a variety of data that is descriptive qualitative sourced from respondents, both orally and in writing and related to the object studied. The data comes from the Main Engine's manual book, monthly machine report book, interview with Engineer Officer, and questionnaire distribution.

III. METHODS OF RESEARCH

The method of analysis to be used by researchers is using SWOT method SWOT analysis method consisting of Strengths, Weakness, Opportunities, and Threats. From the SWOT understanding will be explained one by one, namely:

a. Strength (Strength), which is any power that has to cylinder liner and piston rings can last long. By knowing the power, cylinder liner and piston ring can survive in working hours according to the manual.

b. Weakness, ie any unfavorable or disadvantageous factors to the engine components, in this case the cylinder liner and piston ring.

c. Opportunities (Opportunities), which are all opportunities that exist and can be used for the condition of the cylinder liner and piston ring to meet normal working hours and work normally.

d. Threats, which can cause losses to the cylinder liner and piston ring, spare parts conditions, spare parts distribution, the level of experience and knowledge of machine officers, and the economic condition of the firm.

The analysis on how to solve the impact of oversized cylinder liner on the broken piston ring and surgical parent machine according to SWOT method are as follows:
TABLE I
INTERNAL AND EXTERNAL FACTORS

| Internal Factors | Strengths | Weakness |
|------------------|-----------|----------|
| 1                | Cylinder liner tolerance of 0.3-0.8% | Unavailability of cylinder liner and piston ring spare parts on board. |
| 2                | Measurement and replacement of piston rings every 5000 working hours | The oversized cylinder liner exceeds the allowed tolerance limit |
| 3                | Inspection, measurement, and recondition of cylinder liner every 8000 working hours | Piston rings are often broken due to traffic jams caused by burning crust |
| 4                | Lubrication of cylinder liner according to machine standard and machine specification. | Stacks of burning mud in scavenging air trunk. |

| External Factors | Opportunities | Threats |
|------------------|---------------|---------|
| 1                | Working with agents for spare part distribution of cylinder liner and piston ring to be quickly received on board. | Short period of in port |
| 2                | The use of reconditioned cylinder liners and piston rings while waiting for new parts. | Cylinder liner and piston ring spare parts came too late. |
| 3                | Thorough inspection and replacement of cylinder liner during docking | Quality spare parts cylinder liner and piston ring not in accordance with the specifications |
| 4                | Working with third parties for maintenance of main engines and turbochargers. | The voyage are too short, the weather and the sea conditions that cause the engine to work heavily. |

Next the author performs assessment of factors to determine the Factor Weight Factor (WF) to get the score and rating score for use in the preparation of questionnaires and calculation of SWOT settlement strategy matrix using the table as follows:

TABLE II
SWOT MATRIX WEIGHT VALUE

| Internal factors | Strength indicator          | Handling Urgency |
|------------------|----------------------------|------------------|
| 1                | Cylinder liner tolerance of 0.3-0.8% | 4 3 2 1          |
| 2                | Measurement and replacement of piston rings every 5000 working hours | 4 3 2 1          |
| 3                | Inspection, measurement, and recondition of cylinder liner every 8000 working hours. | 4 3 2 1          |
| 4                | Lubrication of cylinder liner according to machine standard and machine specification. | 4 3 2 1          |

| Internal factors | Weakness indicator          | Handling Urgency |
|------------------|-----------------------------|------------------|
| 1                | Unavailability of cylinder liner and piston ring spare parts on board. | -4 -3 -2 -1      |
| 2                | The oversized cylinder liner exceeds the allowed tolerance limit | -4 -3 -2 -1      |
| 3                | Piston rings are often broken due to traffic jams caused by burning crust | -4 -3 -2 -1      |
| 4                | Stacks of burning mud in scavenging air trunk | -4 -3 -2 -1      |

| External factors | Opportunities indicator | Handling Urgency |
|------------------|-------------------------|------------------|
| 1                | Working with agents for spare part distribution of cylinder liner and piston ring to be quickly received on board. | 4 3 2 1          |
| 2                | The use of reconditioned cylinder liners and piston rings while waiting for new parts. | 4 3 2 1          |
| 3                | Thorough inspection and replacement of cylinder liner during docking | 4 3 2 1          |
| 4                | Working with third parties for maintenance of main engine and turbochargers. | 4 3 2 1          |

| External factors | Threats indicator | Handling Urgency |
|------------------|-------------------|------------------|
| 1                | Short period of in port | -4 -3 -2 -1      |
| 2                | Spare part cylinder liner and piston ring came too late. | -4 -3 -2 -1      |
| 3                | Quality spare parts cylinder liner and piston ring not in accordance with the specifications | -4 -3 -2 -1      |
| 4                | The voyage are too short, the weather and the sea conditions that cause the engine to work heavily. | -4 -3 -2 -1      |

Number 1 : Not urgent                      Number 3 : Urgent
Number 2 : Less urgent                     Number 4 : Very urgent

IV. RESULTS AND DISCUSSION
The result of strategy formulation using SWOT matrix and calculation result from questionnaire to student officer ATT-II class.
After determining the completion strategy using SWOT matrix, the author then distributes the questionnaire to the student officer ATT-II as a participant in determining which strategy is most appropriate to be used as the solution to the problem formulation the author discussed in the previous chapter. The score result can be seen in table below this.

### TABLE III

#### SWOT MATRIX STRATEGY

| Strengths | Weakness |
|-----------|----------|
| 1. Cylinder liner tolerance of 0.3-0.8% | 1. Unavailability of spare part cylinder liner and piston ring on board. |
| 2. The measurement and replacement of piston ring every 5000 machine hours. | 2. The oversized liner cylinder exceeds the allowed tolerance limit |
| 3. Inspection, measurement, and recondition of cylinder liner every 5000 machine hours. | 3. Piston rings are often broken due to traffic jam caused by crust |
| 4. Circular cylinder liner according to machine standard and machine specification. | 4. Stacks of burning mud on scavenging water trunk |

#### Opportunities

1. Working with agents for spare part distribution of cylinder liner and piston ring to be quickly received on board
2. The use of reconditioned cylinder liner and piston ring to wait for new parts.
3. Thorough inspection and replacement of cylinder liner during docking.
4. Working with third parties for maintenance of the parent machine, and turbocharger.

#### Threats

1. The time of in port is too short.
2. Sparepart cylinder liner and piston ring coming late.
3. Quality of spare part of cylinder liner and piston ring not according to specification
4. The shipping line is too short, the weather and the sea conditions that cause the machine to work heavily.

#### ST Strategy

1. Creating the demand planning for spare parts of cylinder liner and piston ring long before the working hours run out so that the company has time for the procurement of spare parts.
2. Make special maintenance and maintenance schedule out of PMS schedule to avoid busy boat activity.
3. Routine care can be done before the schedule of PMS (Planning Maintenance System) or adjusted to the conditions of cylinder liner and piston ring as well as the schedule of the voyage to achieve the goal of maintenance.

#### WO Strategy

1. Check the spare on board routine and make a list of defect lists to report to the company.
2. Recondition of used cylinder liner and piston ring parts to be reused for a while waiting for new parts
3. Routine check of piston ring condition, especially after surging.
4. Regular cleaning of thrunk water screw and piston groove.

### TABLE IV

#### RESULTS OF SWOT QUESTIONNAIRE RECAPITULATION

| No | Strength Indicators | Recapitulation Results | No | Opportunities Indicator | Recapitulation Results | Score | Rating | Score x Rating |
|----|---------------------|------------------------|----|-------------------------|------------------------|-------|--------|---------------|
| 1  | Cylinder liner tolerance of 0.3-0.8% | 2.49 | 4 | 9.96 | 1 | Working with agents for spare part distribution of cylinder liner and piston ring to be quickly received on board. | 3.22 | 4 | 12.88 |
| 2  | Measurement and replacement of piston rings every 5000 working hours. Inspection, measurement, and recondition of cylinder liner every 8000 working hours. Lubrication of cylinder liner according to machine standard and machine specification. | 2.16 | 3 | 6.48 | 2 | The use of reconditioned cylinder liners and piston rings while waiting for new parts. | 2.14 | 3 | 6.42 |
| 3  | 2.25 | 2 | 4.5 | 3 | Thorough inspection and replacement of cylinder liner during docking | 2.59 | 2 | 5.18 |
| 4  | 3.1 | 1 | 3.1 | 4 | Working with third parties for maintenance of Main Engine, and turbochargers. | 2.04 | 1 | 2.04 |
| Sub Total | 10 | 24.04 | Sub Total | 9.99 | 26.52 |

#### Weakness Indicators

| No | Recapitulation Results | No | Threats Indicators | Recapitulation Results | Score | Rating | Score x Rating |
|----|------------------------|----|-------------------|------------------------|-------|--------|---------------|
| 1  | Unavailability of spare part cylinder liner and piston ring on board. | 3.49 | -4 | -13.96 | 1 | Stopover time is too short | 2.1 | -4 | -8.4 |
| 2  | The oversized cylinder liner exceeds the allowed tolerance limit Piston rings are often broken due to traffic jams caused by burning crust | 2.25 | -3 | -6.75 | 2 | Spare part cylinder liner and piston ring came too late. Quality spare parts cylinder liner and piston ring not in accordance with the specifications | 2.78 | -3 | -8.34 |
| 3  | 2.18 | -2 | -4.36 | 3 | The voyage are too short, the weather and the sea conditions that cause the engine to work heavily. | 3.47 | -2 | -6.94 |
| 4  | 2.08 | -1 | -2.08 | 4 | | 1.65 | -1 | -1.65 |
| Sub Total | 10 | -27.15 | Sub Total | 10 | -25.33 |
| Total | -3.11 | Total | 1.19 |
From the results of the assessment of factors that have been compiled in the summary matrix of internal and external factors analysis above, where the value of the score of power (S) = 24.04 and the value of the score of weakness (W) = -27.15 then the amount X) = S + W then the result Y = -3.11 while the value of the score of odds (O) = 26.52 and the value of the threat score (T) = -25.33 then the result sum (Y) = O + T and the result is 1.19 then the point is at (-3.11; 1.19) or in quadrant III see the following picture.

![Fig.1. SWOT strategy quadrant map](image)

V. CONCLUSION

Strategy to minimize the impact of oversized cylinder liner Mains Machine in MT. Ontari is routinely checking spare on board and listing defect lists to report to the company, reconditioning cylinder liner and piston ring parts for reusable spare parts, routine checking of piston ring condition, especially after surgery, regular cleaning of screw water trunk and piston groove.

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