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Preventive Maintenance of Heidelberg Speedmaster CD 102 Machine to Reduce Engine Oil Costs

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***Abstract* - X company is the oldest of several company units engaged in printing and packaging, supported by other units such as paper making, conversion, holograms, engineering, and an integrated total security system. An offset printing machine is one of the main equipment in the production process which has an important role in printing packages in large quantities and quickly. So on an offset printing machine, there will be factors that cause a decrease in the performance of the offset machine, such as a dirty machine environment, inappropriate roller settings, oil leaks, and worn components. Therefore, it is necessary to carry out preventive maintenance on offset printing machines to maintain machine performance in optimal conditions to produce good quality output and maximum machine lifetime. This research aimed to reduce the wasteful use of oil and to reduce the cost of using oil using preventive maintenance methods. The results of this research indicate that the Heidelberg Speedmaster CD 102 offset machine underwent preventive maintenance by checking adjusting roll, leakage, oil level, and noise every day. By checking this, we get the results that the quality of the output produced is better maintained and the lifetime of the machine increases. This increase in engine lifetime can be seen as a result of decreasing engine oil usage from 1182 liters to 450 liters and decreasing costs incurred for engine maintenance, especially oil. The costs incurred for oil use in August 2022 – January 2023 have decreased from Rp. 82,129,000,- to Rp. 31,275,000,-.**

Keywords: Preventive Maintenance, Offset Machine, Heidelberg Speedmaster, Lifetime, Output.

I. INTRODUCTION

Industrial development is currently accelerating rapidly, causing many changes in various sectors. From time to time, industrial development continues to increase, resulting in the term industrial revolution which makes major changes to the industrial sector. At this time the industrial revolution itself has reached stage 4.0 where the industrial stage has gone through 4 stages of revolution which have changed it considerably from the previous era [1]. With current industrial developments, one of the factors to support the success of an industry is the smoothness of the production process. Therefore, maintenance activities are needed to maintain the components on the machine so that operations and output can be maximized [2].

Preventive Maintenance is maintenance that is carried out regularly and on a schedule. Preventive maintenance depends on the right operating time. Early maintenance causes higher costs and reduces the effectiveness of machine performance which is not optimal [3]. The offset machine, usually called a lithography machine invented by Alois Senefelder, has the principle that oil and water do not mix. This is because the printing process uses a thin metal plate that can be curved on a rotating printing machine cylinder [4]. Offset is a planographic printing method, which means that the printing area and the non-printing area are on the same plane, and the substrate is pressed into contact with the entire surface [5]. The image area is oleophilic (accepts ink). Non-image areas are hydrophilic (receptive to water). There are 2 classifications of offset printing machines, namely sheet-fed and web-fed offset. Sheet-feed offset is a printing machine that feeds and prints on individual sheets of paper (or other media) using an offset lithographic printing method. Meanwhile, web-fed offset is a press that prints on a continuous web, from paper fed from a roll and threaded through the press. Although the principles of offset printing are the same for both, the processing of sheets and rolls is very different. The basic principle of printing is the mutual repulsion of oil and water. The printing plate consists of a water-receiving part and an ink-receiving part. The printing image itself can accept ink; non-printed parts can accept water [6]. With each rotation, the printing plate first passes through a water roller, which delivers water to the unprinted areas of the plate. The presence of water means the area cannot accept ink. Then the plate passes through an ink roller, which applies ink to the waterproof areas of the plate. The inked image is transferred from the printing plate to a "blanket" cylinder. The blanket is made of rubber and transfers the image to the paper – the cycle is repeated with each rotation onto new paper [7]. A sheet-fed press consists of a

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feeder, one or more printing units, a transfer device for moving the paper through the press, delivery, and various auxiliary devices (such as a control console). The feeder is the part that lifts and forwards sheets of paper or other media from the stack to the first printing unit. A transfer device is a series of cylinders and grippers that facilitate the transport of sheets through the printing press. Delivery is the part that receives and stacks printed sheets. In a sheet-fed printing machine, there are five main units, namely the feeding unit, printing unit, inking unit, dampening unit, and delivery unit. The feeding unit, in this section where the paper is removed from the top of the stack table, passed over the feed board to the front stop, placed laterally on the feed board, and fed into the first printing unit. The inking unit is a series of rollers that apply a metered ink film to the printing plate. A dampening unit is a system with a series of rollers that wets the printing plate with a water-based dampening solution containing additives such as acid, gum arabic, and isopropyl alcohol or other wetting agents. Dampening systems used for sheet-fed offset lithography are classified into two categories – intermittent flow (doctor or conventional) and continuous flow (such as alcolor) [8]. The printing unit of a sheet-fed offset lithography press usually consists of three main cylinders, and a system for dampening and inking the plates. The three main cylinders are the plate cylinder, blanket cylinder, and impression cylinder. Delivery unit, this unit consists of several gripper bars which are used to transfer printed paper from the impression cylinder gripper to the delivery unit stack board. The delivery unit is the part where printed sheets are stacked one on top of another.

In production, one machine is interconnected with another machine, if one of the machines is damaged then the production process will be affected, production targets will be reduced, funds for repairing damage will be high and in the end, the company will suffer losses [9]. Maintenance activities are generally considered as supporting activities in the production process. This activity is very important because it contributes directly to the smooth production process and productivity. Therefore, if maintenance is planned well, the machine will always be in good condition and ensure a smooth production process in the company. Apart from that, good machine conditions will also affect the quality of product output [10]. Maintenance is one of the areas of modern management that is used to increase machine productivity and achieve quality products. This increases equipment efficiency and reduces costs. Factory equipment maintenance strategies are crucial for production efficiency. This is very important because it reduces downtime to increase the productivity of each particular type of equipment [11]. With systematic maintenance, it is possible to achieve savings in costs, materials, components, and labor [12]. Preventive Maintenance is naturally carried out before there are production disruptions and major damage. This maintenance is carried out at predetermined intervals. Preventive Maintenance will not only prevent damage but will also increase output, product quality, and machine contents [13].

The main aim of this research is to reduce the use of engine oil and reduce the costs of using engine oil using preventive maintenance methods. If an abnormality occurs on the machine, it will result in downtime which will hamper the production process. So, in this research, preventive maintenance analysis was carried out on the Heidelberg Speedmaster CD 102 engine regarding output results and reduction in oil usage costs.

II. METHODOLOGY

2.1 Method Analysis

This research uses a Heidelberg Speedmaster CD 102 machine as an analysis medium. The Heidelberg Speedmaster CD 102 engine analysis carried out in this research used qualitative descriptive and preventive maintenance methods. The postpositivist methodology used in qualitative research examines conditions and symptoms that occur naturally using researchers as the main instrument and observations are carried out as data analysis [14].

The Heidelberg Speedmaster CD 102 offset printing machine which can be seen in Figure 1 is a sheet-fed offset printing machine. Heidelberg Speedmaster CD 102 machine located at X-company is a sheet-fed printing machine with a multicolor sheet-fed press configuration and the type of press machine is inline press. The Heidelberg Speedmaster CD 102 machine functions as a machine for printing packaging products which are the company's main products.

The Heidelberg Speedmaster CD 102 machine is a universal straight press for commercial printing, packaging, and labels. Equipped with innovative technology, this machine provides flexible processing for a wide range of jobs and materials with maximum flexibility. Its efficiency and cost-effectiveness are impressive. The Speedmaster CD 102 achieves constant high print quality at speeds up to 15,000 sheets per hour [15]. The following are the specifications for the Heidelberg Speedmaster CD 102:

Table 1: Specification *Heidelberg Speedmaster* CD 102

Printing stock	
Max. sheet size	720 mm × 1020 mm (28.35 in × 40.16 in)
Min. sheet size	340 mm × 480 mm (13.39 in × 18.90 in)
Max. print format	710 mm × 1020 mm (27.95 in × 40.16 in)
Thickness	0.03 mm – 1.00 mm

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	(0.0012 in – 0.039 in)
Gripper margin Thickness printing stock < 0.8 mm (0.00315 in) > 0.8 mm (0.00315 in)	 10 mm – 12 mm (0.39 in – 0.47 in) 11 mm – 12 mm (0.43 in – 0.47 in)
Printing output	
Maximum	15000 sph
Plate cylinder	
Cylinder undercut	0.12 mm (0.0047 in)
Distance from the lead edge of the plate to the lead edge of the print	43 mm / 52 mm (1.69 in / 2.05 in)
Plates	
Length × width	790 mm × 1030 mm (31.10 in × 40.55 in)
Thickness	0.20 mm – 0.30 mm (0.0079 in – 0.012 in)
Blanket cylinder	
Length × width Blanket (metal-barred)	840 mm × 1052 mm (33.07 in × 41.42 in)
Blanket thickness	1.95 mm (0.077 in)
Cylinder undercut	2.30 mm (0.091 in)
Length × width Packing sheet	735 mm × 1030 mm (28.94 in × 40.55 in)
Coating blanket cylinder	
Length × width Coating blanket (metal-barred)	800 mm × 1048 mm (31.50 in × 41.26 in)
Length × width Coating plate	780 mm × 1030 mm (30.71 in × 40.55 in)
Max. coating area	710 mm × 1020 mm (27.95 in × 40.16 in)
Cylinder undercut	3.20 mm (0.13 in)
Distance from lead edge of coating plate to lead edge of coating	43 mm (1.69 in)
Pile heights (incl. Pile table and pile support plate	
Preset Plus feeder	1320 mm (51.97 in)
Preset Plus delivery	1295 mm (50.98 in)
Sample configuration	
Basis: Speedmaster CD 106·6+L with two delivery extension modules	
Number of printing units	6
Number of coating units	1
Length	15935 mm
Width incl. peripherals	4782 mm
Height incl. open printing unit guard	2715 mm

Primary and secondary data from companies are used in this research as data sources. Primary data is information that a business receives in standard form but needs to be processed further. A description of the company's maintenance procedures from the head of the service department constitutes this type of primary data. Meanwhile, secondary data is information and data provided by the company in its original form. This type of data includes company organizational structure, maintenance cost data, and engine oil usage data. The method used in this research is preventive maintenance analysis. Preventive Maintenance is carried out before there are production disruptions and major damage. This maintenance is carried out at predetermined intervals. Preventive Maintenance will not only prevent damage but will also increase output, product quality, and machine contents.

Formula to calculate the effectiveness of preventive maintenance on Heidelberg Speedmaster CD 102 machines:

$$Oil\ Use\ (\%) = \frac{Oil\ Use\ After\ Preventive\ Maintenance}{Use\ of\ Oil\ Before\ Preventive\ Maintenance} \times 100\%$$

$$Cost\ Effectiveness\ (\%) = \frac{Costs\ After\ Preventive\ Maintenance}{Oil\ Costs\ Before\ Preventive\ Maintenance} \times 100\%$$

III. RESULT AND DISCUSSION

The first thing that is done in the preventive maintenance analysis method this time is to look for things that cause the machine to become damaged and result in long downtime, thereby hampering production. Of the 14 machines observed, the first thing that needs to be done to prevent machine downtime is to check or calibrate the dampening roll. The calibration carried out during preventive maintenance this time was by adjusting the roll. Adjusting rolls on the Heidelberg Speedmaster CD 102 machine is the process of calibrating the position of the rolls on the machine. The rollers on an offset machine are used to move ink from the machine components to the printing media. Checking the adjusting roll on the Heidelberg Speedmaster CD 102 offset machine is very important to ensure optimal printing results that comply with standards and with this calibration, it will be easier for the printing machine to achieve the desired quality. Therefore, by having calibration on the printing machine, it will be possible to reduce the number of defects in production results which in turn can also reduce production costs [16]. This check is carried out every day when the production process starts.

The second preventive maintenance is checking noise and oil levels. Noise on the Heidelberg Speedmaster CD 102 engine is an unnatural or irregular sound that is heard when the engine is operating. Usually, noise can be caused by various factors, such as environmental conditions, inappropriate machine use, or inappropriate or worn machine components. The presence of excessive noise on the Heidelberg Speedmaster CD 102 engine can indicate problems with the engine and require maintenance or repair to ensure optimal engine performance [9]. Therefore, the preventive maintenance team always checks every day to indicate if there is noise on the Heidelberg Speedmaster CD 102 engine. The lubrication points that must be carried out to reduce noise are the feeder drive axle, feeder transport chain, Vanbelt roll wheel nipple, handlebar journal box, journal box teeth, ass roll bearing, gripper cylinder impression, camp follower / centrix, delivery chain, nipple, and gripper delivery bearing.

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The oil level on the Heidelberg Speedmaster CD 102 offset machine is the level of lubricant (oil) in the engine lubricant system. Engine oil is used to lubricate engine components and help prevent damage due to friction. The engine oil level must always be in proper condition to ensure optimal engine performance and extend engine life. The oil level on the Heidelberg Speedmaster CD 102 engine can be checked via the oil tank or by using the indicator on the engine. Checking the correct oil level is very important to ensure optimal engine performance and prevent damage to engine components. If the oil level is below the minimum limit then oil must be added [17].

The next preventive maintenance is to check for oil leaks in the engine. Leakage is a serious problem with the Heidelberg Speedmaster CD 102 offset engine. Oil leaks can cause damage to engine components, reduce engine performance, and accelerate engine damage [18]. Oil leaks can also affect print quality and create an unhygienic work environment. Therefore, it is important to deal with oil leaks quickly and carry out regular maintenance to prevent oil leakage problems [19]. After researching, several things caused oil leaks in the Heidelberg Speedmaster CD 102 engine, namely the oil seal and oil pressure in the engine. This makes the use of oil in the engine more wasteful [20]. The following is oil usage data before preventive maintenance was carried out on the Heidelberg Speedmaster CD 102 engine.

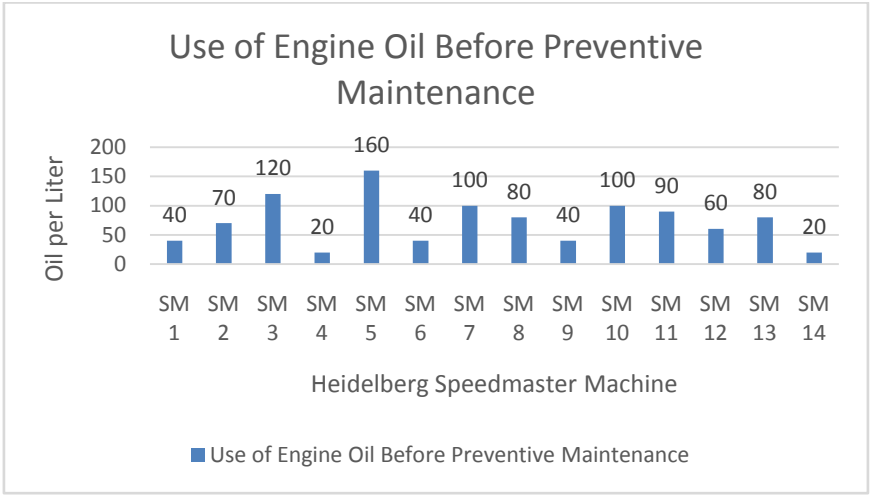

Figure1: Engine oil usage data before preventive maintenance

Based on the data in Figure 1 above, it can be said that the use of Heidelberg Speedmaster CD 102 engine oil before preventive maintenance was excessive and wasteful. From this data,X-company costs IDR 82,149,000 for oil use alone. Therefore, researchers carry out preventive maintenance to reduce costs and oil usage. So the results obtained from using oil are as follows.

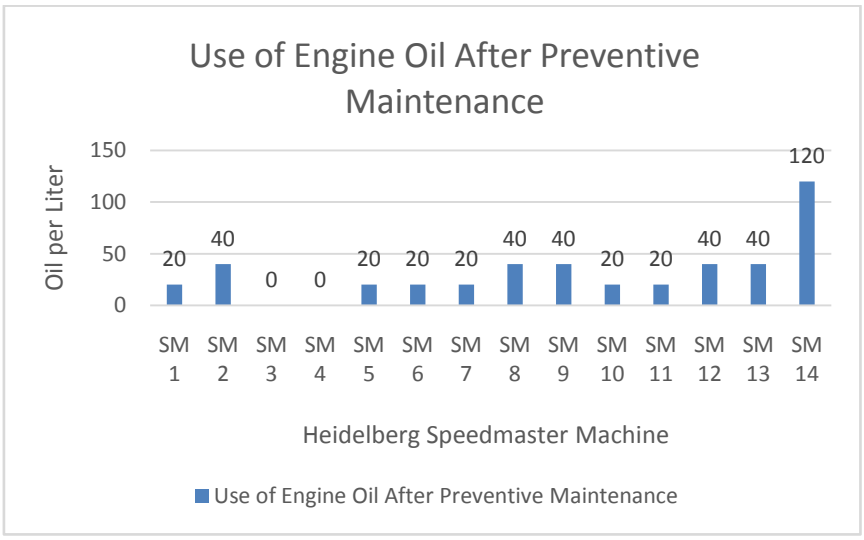

Figure 2: Engine oil usage after preventive maintenance

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From the data in Figure 2, it can be seen that after preventive maintenance was carried out on the Heidelberg Speedmaster CD 102 engine, oil use was reduced significantly, which can reduce the costs incurred byX-company becomes Rp. 31,275,000. However, in Figure 2 on the SM 14 engine, there is an increase in oil usage due to servicing and total oil changes. The following is a comparison between preventive maintenance and after-preventive maintenance.

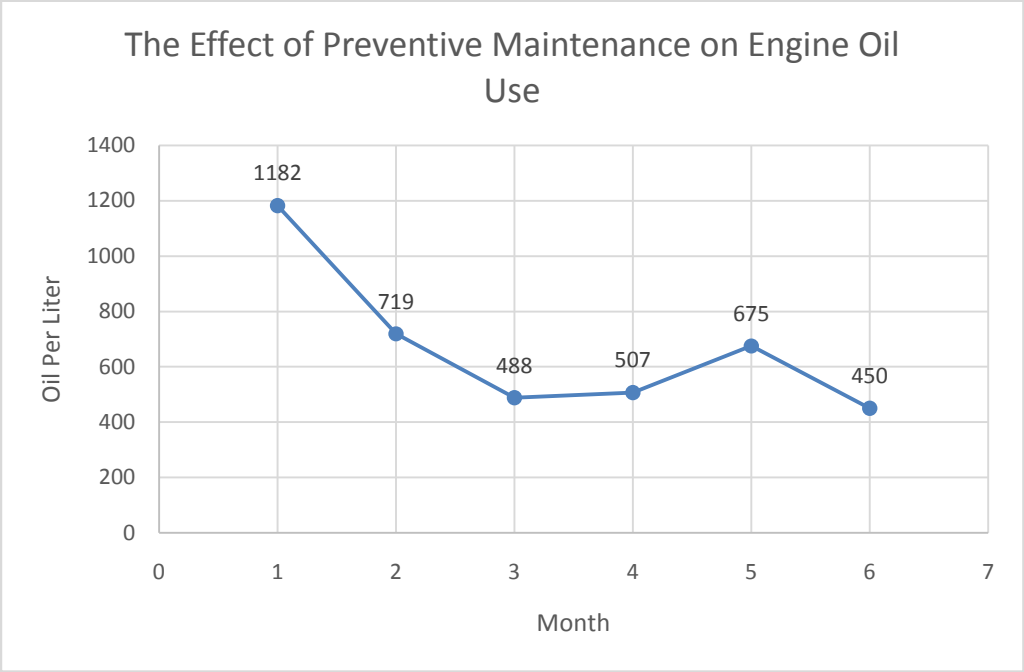

Figure 3: The effect of preventive maintenance on engine oil use

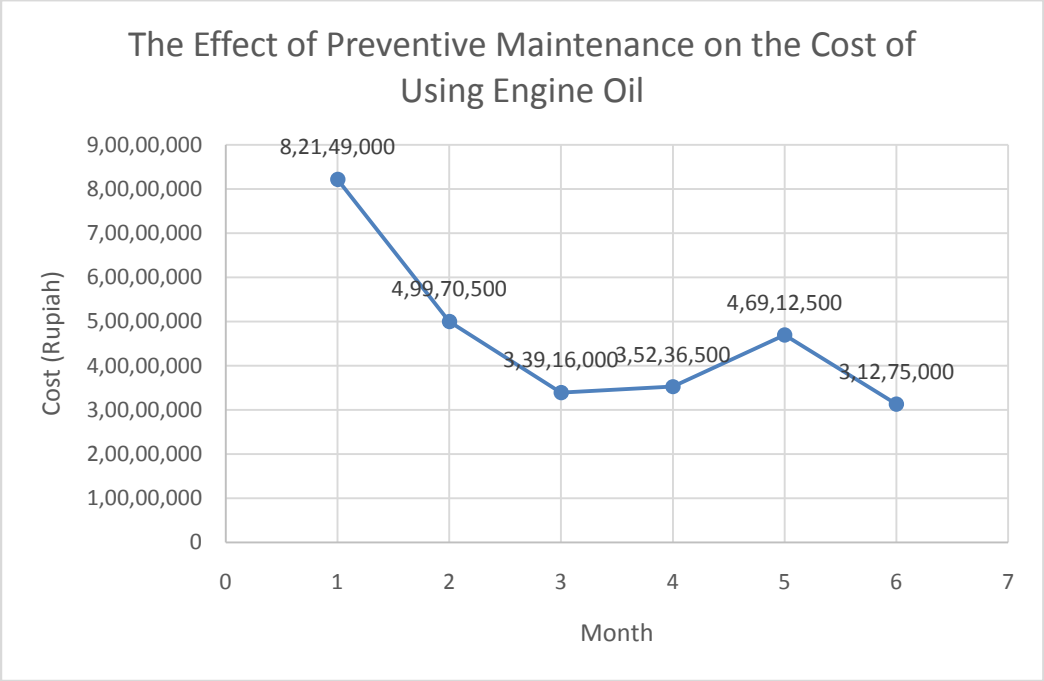

Figure 4: Oil usage costs

The results of calculating oil usage on the Heidelberg Speedmaster CD 102 engine before and after preventive maintenance can be seen in Figure 3. It is known that after calculating preventive maintenance there is a reduction in oil costs from 1182 liters to 450 or 38%. The calculation of the cost of using oil on the Heidelberg Speedmaster CD 102 engine before and after preventive maintenance can be seen in Figure 4. It is known that after calculating preventive maintenance there is a cost savings of 37%.

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IV. CONCLUSION

Based on the previous discussion, it can be concluded that the results of calculating oil use before and after preventive maintenance have decreased from 1182 liters to 450 liters. This is very effective and can reduce oil usage costs from IDR 82,149,000 to IDR 31,275,000. From these results, the use of engine oil decreased by 38% and the cost of using engine oil decreased by 37%.

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