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# TWO-LEVEL AIR COMPRESSOR MAINTENANCE OPTIMIZATION ON SV VESSELS OF STELLA 28

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## ABSTRACT

*A compressor is one component of the working air system on board the ship which is related to carrying out smooth ship motion. Auxiliary aircraft two-level air compressors in operation on board ships for the start process of the main engine, generator, and bow thruster which are important parts in the ship, and also for the process of processing ship motion with ships using a pneumatic system gearbox. The purpose of this study was to optimize the maintenance of two-level air compressors on SV Ships. Stella 28. This research is a research with qualitative descriptive analysis. Data collection techniques are obtained through field research by combining observation, documentation, interview, and literature study methods. The result of this study is the optimization of maintenance and two-level air compressors on SV ships. Stella 28 at PT. Sowohi Kentiti JayA is good. Treatments carried out in SV. Stella 28 includes routine replacement of compressor LO according to the manual book, sediment water flushing in the air pipe and also on wind bottles, and checking the manometer and thermometer that have been done properly.*

***Keywords**: Maintenance, Air Compressor, Two Level*

## INTRODUCTION

Auxiliary aircraft two-level air compressor in operation on board for the *start process of the main engine, generator,* and *bow thruster* which is an important part of the ship (Zakiah et al., 2022) and also for the process of processing ship motion with ships that use *a pneumatic* system *gearbox* (Siswo et al., 2022). The compressor is one component of the working air system on board the ship (Kumar et al., 2017; Nitonye, 2017) which is related to carrying out smooth ship motion (Antra et al., 2019). With a compressor that functions properly, the readiness of the availability of air in air bottles will be guaranteed so that at any time it can anticipate the needs of motion processing.

The main function of working air on board is as a runner on motor *ships ( motor ship*), as the main engine runner field (Semin & ST, 2019). Other functions can be used as cleaners, *pneumatic* equipment drives, hydroponics tank fillers, energy use in pneumatic control systems, and other fields (Rachman & Rizki, 2020). Compressors function to compress air or gas and usually suck air from the atmosphere, but some suck air or gas that is higher pressure than atmospheric pressure (Syamsuri et al., 2021). In this case, the compressor works as an amplifier, on the contrary, there is also a compressor that sucks gas that is lower pressure than atmospheric pressure, in this case, the compressor is called *a vacuum pump field* (Hutabarat, 2019).

Compressors are used to produce compressed air, where their role is very important on board, whether used to process motion or for other purposes, so compressor maintenance is an effort to obtain optimal results (Stazić et al., 2020), namely proper air pressure. On board using a piston air compressor, at each pressure level, 4 processes occur (Senda & Tona, 2020). When air is sucked in and compressed in the compressor cylinder, changes in air pressure occur according to the change in volume caused by motion in the cylinder. PT. Sowohi Kentiti Jaya is a national shipping company. PT. Sowohi Kentiti Jaya

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is engaged mainly in industrial services and offshore gas in Indonesia, this company has 12 fleets consisting of *supply vessels* and *anchor handling*, one of which is SV Ships. STELLA 28 (Totok, 2018).

Through direct observation in the field, the ship has not been maximized regarding the maintenance of two-level air compressors. Because of the many events and problems with the air compressor, it can hamper the smooth process of sailing a ship. Problems such as oil coming out along with pressurized wind caused by piston rings or *cylinder liners* that have worn out (Chen et al., 2017). The windpipe leaks or ruptures so that it cannot supply pressurized air to the wind bottle caused by a *safety valve* that does not work and there is also a blockage in the filter or windpipe. From the discussion above, researchers want to explore the optimization of aircraft maintenance auxiliary two-level air compressors that occur on SV ships. STELLA 28 belongs to PT. Sowohi Kentiti Jaya.

## METHOD

This research is a study with qualitative descriptive analysis, namely by describing the maintenance of two-level air compressor auxiliary aircraft that occur on SV ships. STELLA 28 belongs to PT. Sowohi Kentiti Jaya. This is as stated by Sugiyono in Subekti et al., (2022) that qualitative research uses research methods according to the philosophy of postpositivism which examines the natural condition of objects. In this study, the researcher is a key instrument (Fadli, 2021). Meanwhile, data collection techniques are obtained through field research combining observation, documentation, interview, and literature study methods. While data analysis is carried out in a triangulation (combined) which is not aimed at finding the truth but to increase the understanding of researchers about the data and facts obtained (Bachri, 2010). Data analysis is inductive/qualitative, and the results of the study emphasize the meaning of the generalization (Fadli, 2021).

Figure 1. SV ship. STELLA 28 belongs to PT. Sowohi Kentiti Jaya.

Figure 1 is the SV ship. STELLA 28 according to ship *particular* is an Indonesian-flagged ship with *the call sign* JZKF which was built in 1998. This ship has an overall length of 60.8 Meters and a width of 11.6 Meters. *The main* engine is 2 x Yanmar 1750 HP with a total of 3500 HP, whereas the auxiliary engine is 2 x *Caterpillar* (250 KVA) 60 Hz, 0.8 PF, 415 V, 3 *Phase.* The capacity of the ship with passengers is 14 people and the *crew* is 14 people. Cargo capacity of 373 $m^3$ for fuel oil, 148.5 $m^3$ for *fresh water*, 650 mt for *cargo* deck, and 350 $m^2$ for *clear deck space.* Here is the SV Ship. STELLA 28 belongs to PT. Sowohi Kentiti Jaya (Nanda, 2018).

## RESULTS AND DISCUSSION

Air compressor in SV. STELLA 28 is one of several auxiliary aircraft on board. The compressor function is an auxiliary aircraft that functions to get working air accommodated in air tubes that have a pressure of more than 1 ATM (20 - 30 kg / $cm^2$). On the ship SV. STELLA 28 installed 3 compressors

that have the purpose that if one of the compressors is damaged or jammed, there is still another that can replace it. Air compressor on SV. STELLA 28, which is the main air compressor of 2 units that functions to fill the working air on the main air bottle alternately. A compressor is a machine to increase air pressure by compressing gas or air that works from the shaft. Compressors usually work by sucking atmospheric air. If the compressor works at a pressure higher than atmospheric pressure then the compressor is called a *booster,* and if the compressor works under atmospheric pressure it is called a vacuum pump. Gases have a great ability to store energy union volume by increasing their pressure, but some things must be considered: temperature increases in compression, cooling in expansion, and leakage that easily occurs. Figure 2 follows a picture of the compressor in SV STELLA 28.

Figure 2. Two-level air compressor SV STELLA 28

The volume of air produced by the compressor must be following the needs. If the compressor continues to work, the pressure and volume of air will continue to increase beyond the needs and be harmful to the equipment. To set the volume and pressure limits produced by the compressor, a tool commonly called an *unloader is* used. Load relievers can be classified according to their working principle: suction valve load relievers, valve gap load relievers, suction total load relievers, and load relievers with automatic breakers. A load reliever that is used to lighten the load when the compressor is started so that the drive can run smoothly is called the initial load reliever. The characteristics, working, and use of various types of load relievers.

A compressor when viewed from how it works, there will be two types of compressors, each of which works differently. The first type is a compressor with a working method and the second is a compressor with *a dynamic* working method. Kompresor type positive displacement. This compressor model works on the positive *displacement principle* where the air is compressed by mechanical action, and then at the same time the volume of the chamber is reduced, thus the pressure inside will naturally rise. This high pressure is used for various purposes following the designation of the compressor earlier. This positive displacement model compressor is used in reciprocating compressors and rotaries.

Meanwhile, dynamic model compressors, it is a continuous-flow engine where rotating elements quickly circulate air, changing pressure. It draws in the air on one side and compresses it with mass acceleration that increases the kinetic energy so that it turns into high pressure. The increase in air pressure occurs by converting energy from the speed of air into pressure, the volume of the space is fixed, but the air in the space is given speed. Then at the same time, the speed is converted into pressure. This can happen because the air in the room whose volume remains under pressure. Compressors that use this *dynamic* model are usually on *turbo axial flow* tools.

Broadly speaking, compressors can be classified into two parts, namely Positive Displacement compressor, and Dynamic compressor, (Turbo), Positive Displacement compressor, consists of a Reciprocating and Rotary, while a dynamic compressor, (turbo) consists of a Centrifugal and ejector. In this type, 2 chambers can suck and press, but each side has a different level of pressure. If the piston moves to the TMA, the upper thorax performs pressure and the lower thoracic suction step occurs.

Conversely, if the piston moves to the TMB, the upper thorax occurs suction stroke, while the lower thorax performs a high level of pressure. To get an efficient air density, every air that has been pumped must go through a cooling vessel (cooler), both from low pressure and high pressure. Each pressure level must be available manometer to find out the number of techs each. To prevent back pressure from the vessel, before entering the vessel a non-return valve is installed.

The air outside is sucked in by the low-pressure piston through a *filter* and enters the cylinder through a low-pressure suction valve. After being compressed in cylinders. Air exits through the low-pressure pressure valve, then the air is cooled at the intercooler, and then the air enters the high-pressure cylinder through the high-pressure suction valve and the air exits through the intercooler to the air tube (wind bottle) through the high-pressure pressure valve. As long as the compressor is working, there needs to be cooling, cooling is taken from seawater and so that the compressor does not experience damage, certain parts are installed with *Zinc Anode* to avoid corrosion. Although with different propulsion but the functions of both are the same. If one air compressor is damaged, the other compressor can replace it. The definition of an electric motor is a device or aircraft that when given electricity will produce rotational power, then the rotational power is used to drive the air compressor by connecting the *pully wheel* with the *v belt* on the motor.

Air compressors that use diesel propulsion are usually of the auxiliary air compressor type. Auxiliary air compressors on ships are used in emergencies when the main air compressor is damaged or jammed. The auxiliary air compressor is installed far apart from the main air compressor because it uses fuel that is diesel, and the auxiliary air compressor is made smaller because its function is only to assist the main air compressor.

The cooling system on the ship uses seawater which means the air from the compressor is cooled with seawater through *an intercooler.* In compressor cooling systems that use seawater, regular maintenance is needed because of the nature of seawater which tends to eat / damage metals, seawater is used as a cooling medium first through a seawater filter but often there are still impurities that are carried away, and settle on the *intercooler,* so it needs regular maintenance and repair as early as possible. Inside the compressor, there needs to be a lubrication system that functions to lubricate the parts in the compressor system. The lubricating oil used is median with SAE 40. In addition to lubricating important parts, it is also used to lubricate moving parts so that they do not wear out and break quickly. At low temperatures lubricating oil should not cause impurities and deposits, at high temperatures lubricating oil should withstand high temperatures.

Lubricating oil must always be considered so that the compressor can work properly without interruption. Lubricating oil should not get dirty because it can damage the compressor. Dirty lubricating oil should be immediately replaced with a new one. The height of the lubricating oil can be seen through the glass of lubricating oil. Adding and replacing lubricating oil can be done every 3 (three) months or when the lubricating oil runs out.

The function of the air compressor is for *emergencies* when the main air compressor is damaged/jammed and to fill the air in auxiliary bottles. With a compressor that functions properly, the readiness of the availability of air in the air bottle will be guaranteed so that at any time it can anticipate the needs of motion processing. In addition, the compressor on SV STELLA 28 is used for the main engine start process, *auxiliary engine, bow thruster,* and also to run pneumatic units. The working diagram is illustrated in Fig. 3 below.

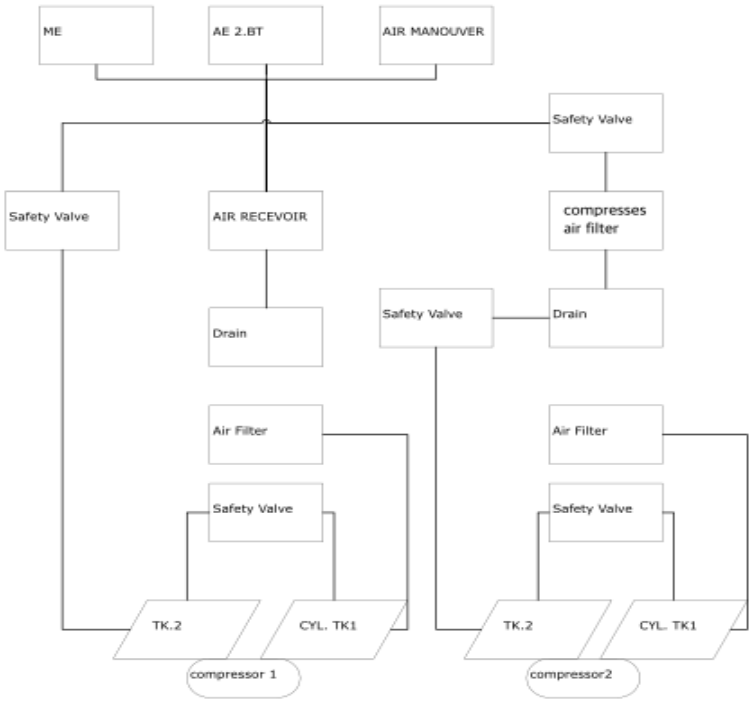


Figure 3. Working diagram of two-level air compressor on vessel SV STELLA 28

In the maintenance of an air compressor, it is not difficult if the workers who operate it are not careless, but must always pay attention to the ways that are done (Xenos et al., 2015; Xenos, Kopanos, et al., 2016; Xenos, Lunde, et al., 2016). Treatment of valves, for example, suction valves, pressure tubes, and security valves. The following are good maintenance methods on the compressor including: checking the charter oil contained in the compressor unit, the oil on the *charter* must be checked every change of guard hours (Kopanos et al., 2015; Prytz et al., 2015) or when an abnormal sound arises coming from the compressor, the goal is that the compressor is always in good condition (Chen et al., 2017). Pay attention to the packing material, this must be considered because if the *packing* is bad it will cause leakage in the *head cylinder* which causes air compression to be imperfect. Check before using safety devices, packing, seals, and others. Determine the schedule for each change of lubricating oil if the instructions are carried out, then the compressor can work properly and safely, besides that the workers who operate it must be proficient. Kompresor on ship SV. STELLA 28 uses SHELL MARINE S40 *lubricating oil* with SAE40. The oil replacement process in this compressor is carried out every 250 *running hours*. Every change of oil guard hours is always checked for volume and colour. Good compressor oil is whitish and odorless. Inspection of the piston ring and *nonreturn valve* is carried out at the time of docking only or if in an emergency to allow for over-haul then do not wait for the *docking* time for the over houl process (Zhou et al., 2017).

Lubrication function on two-level air compressors on SV vessels. STELLA 28 is to reduce friction that occurs, reduce vibrations that occur, reduce engine sound, and increase engine power in the *system*, to leaks that usually occur in air compressors on SV ships. STELLA 28 is caused by damaged and worn scal, but *leaky* packing. How to maintain the air compressor air filter on SV ships. STELLA 28 sama the case with the replacement of LO, the air filter is also cleaned a maximum of 250 *running* hours, but if it looks like it has started to get dirty and the working hours have not reached the specified then the duty officer will clean or order the oiler to clean with the help of machine cadets on guard. How to maintain and repair *the air compressor safety valve* on SV ships. STELLA 28 is a *safety valve* on SV compressors.

STELLA 28 is found in the head cylinder, high-pressure, and low-pressure *head cylinders*. If the spring contained in the safety valve is weak, the *safety valve* is not able to work optimally, the spring will be replaced with available *spare parts*. Maintenance *air recevoir* (tabung udara) on SV Ships. STELLA 28 In addition to knowing how to use the air tube, we should also know how to maintain the air tube for the cleaning process on the inside of the air tube only at the time of docking considering that

the ship SV. STELLA 28 which has a busy work schedule. Other maintenance methods include the check and manometer must work properly, the spout valve check must be maintained in good condition, the discharge valve check and filling valve must be in good condition and ready to use, and the safety valve check must be able to work automatically properly, Checking the spout of dirt - dirt in the form of a mixture of lubricating oil and water, paying attention to the regulation of the working pressure used, avoiding excess air following the provisions, paying attention to the work of the safety valves, paying attention to the work of the valves, namely filling tubes, spout valves, discharge valves and others and in around the air tube must be kept clean.

Routine maintenance includes the state of the engine running (Adamson et al., 2017; Jung et al., 2017; Nordal & El-Thalji, 2021), it is expected that the air bottle will remain open, so as not to be able to *hack* the *cylinder* on the SV two-level air compressor. STELLA 28, *packing* in an air compressor serves to close between the two objects so that there is no leakage, be it liquid, gas, or air.

## CONCLUSION

From the results of the study, it can be concluded that the maintenance and two-level air compressor on SV. STELLA 28 at PT. SOWOHI KENTITI JAYA is good. Treatments carried out in SV. STELLA 28 includes routine replacement of compressor LO according to the manual book, sediment water flushing in the air pipe and also on wind bottles, and checking the manometer and thermometer that have been done properly. Common obstacles in the treatment of SV. STELLA 28 is: The spare parts contained on the ship are still minimal if there is damage the ship must place an order to the office in advance, and also the delivery process is quite long, so maintenance is less than optimal.

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## BIBLIOGRAPHY

Adamson, R., Hobbs, M., Silcock, A., & Willis, M. J. (2017). Integrated real-time production scheduling of a multiple cryogenic air separation unit and compressor plant. *Computers and Chemical Engineering*, *104*, 25–37. https://doi.org/10.1016/j.compchemeng.2017.04.001

Antra, A., Djabier, A., & Syahrisal, S. (2019). Analisis Menurunnya Produksi Udara Bertekanan Di Kapal KM. Armada Persada. *JURNAL KARYA ILMIAH TARUNA ANDROMEDA*, *3*(8), 15–26.

Bachri, B. S. (2010). Meyakinkan validitas data melalui triangulasi pada penelitian kualitatif. *Jurnal Teknologi Pendidikan*, *10*(1), 46–62.

Chen, Y., Han, W., & Jin, H. (2017). Proposal and analysis of a novel heat-driven absorption–compression refrigeration system at low temperatures. *Applied Energy*, *185*, 2106–2116.

Fadli, M. R. (2021). Memahami desain metode penelitian kualitatif. *Humanika, Kajian Ilmiah Mata Kuliah Umum*, *21*(1), 33–54.

Hutabarat, B. (2019). *Analisis unjuk kerja pompa sentrifugal dengan variasi head*. Universitas Medan Area.

Jung, J., Lee, W. J., Park, S., Kim, Y., Lee, C.-J., & Han, C. (2017). Improved control strategy for fixed-speed compressors in parallel system. *Journal of Process Control*, *53*, 57–69. https://doi.org/10.1016/j.jprocont.2017.02.007

Kopanos, G. M., Xenos, D. P., Cicciotti, M., Pistikopoulos, E. N., & Thornhill, N. F. (2015). Optimization of a network of compressors in parallel: Operational and maintenance planning - The air separation plant case. *Applied Energy*, *146*, 453–470. https://doi.org/10.1016/j.apenergy.2015.01.080

Kumar, S., Pradhan, P. K., Khan, Z. H., Kumar, B. A., & Chaithanya, M. (2017). Design and developing

of compressed air engine. *International Research Journal of Engineering and Technology (IRJET)*, *4*(05), 1468–1474.

Nanda, T. P. (2018). *Kurang optimalnya kerja lifter pin pada saat towing barge di SV. Stella 28*. POLITEKNIK ILMU PELAYARAN SEMARANG.

Nitonye, S. (2017). *Compressed Air System Design for an Ocean Going Tug Boat in the Tropical Region*.

Nordal, H., & El-Thalji, I. (2021). Assessing the technical specifications of predictive maintenance: A case study of centrifugal compressor. *Applied Sciences (Switzerland)*, *11*(4), 1–17. https://doi.org/10.3390/app11041527

Prytz, R., Nowaczyk, S., Rögnvaldsson, T., & Byttner, S. (2015). Predicting the need for vehicle compressor repairs using maintenance records and logged vehicle data. *Engineering Applications of Artificial Intelligence*, *41*, 139–150. https://doi.org/10.1016/j.engappai.2015.02.009

Rachman, A., & Rizki, G. (2020). Optimalisasi Perawatan Kompresor Udara Guna Menunjang Operasional Mesin Induk di Kapal MT Java Palm. *Meteor STIP Marunda*, *13*(2), 66–70.

Semin, S. T., & ST, E. M. B. Z. (2019). *Permesinan bantu pada kapal modern volume 1: permesinan geladak*. Airlangga University Press.

Senda, P. J. M., & Tona, T. (2020). Analisis Menurunnya Produksi Udara Bertekanan Yang Dihasilkan Oleh Air Compressor di Kapal SPOB. CINTIANA PRATAMA. *JURNAL VENUS*, *8*(2), 30–40.

Siswo, M., Subekti, J., Astriawati, N., & Setiyantara, Y. (2022). Upaya Perawatan Kompresor Udara Dua Tingkat Untuk Menghasilkan Udara Bertekanan Tinggi Di Kapal KM. SK3. *Jurnal Sains Teknologi Transportasi Maritim*, *4*(2), 21–27.

Stazić, L., Knežević, V., Orović, J., & Mihanović, L. (2020). Maintenance Interval Adjustment Based on the Experience, Case Study of Marine Air Compressor System. *NAŠE MORE: Znanstveni Časopis Za More i Pomorstvo*, *67*(2), 146–152.

Subekti, J., Wibowo, W., Astriawati, N., & Fadholy, M. H. (2022). Optimalisasi Perawatan Sistem Pendingin Mesin Utama Tipe Hansin GLU28AG Pada Kapal. *Dinamika Bahari*, *3*(1), 60–68.

Syamsuri, T. U., Mukti, H., & Duanaputri, R. (2021). KONTROL MOTOR KOMPRESOR MENGGUNAKAN VARIABLE SPEED DRIVE (VSD) VACON TIPE NXP. *Prosiding Seminar Nasional Teknologi Elektro Terapan*, *5*(1).

Totok, T. W. (2018). Sistem Perawatan Cylinder Liner Untuk Menunjang Kelancaran Kinerja Mesin Induk SV. Minerva 88 PT. Sowohi Kentiti Jaya. *KARYA TULIS*.

Xenos, D. P., Cicciotti, M., Kopanos, G. M., Bouaswaig, A. E. F., Kahrs, O., Martinez-Botas, R., & Thornhill, N. F. (2015). Optimization of a network of compressors in parallel: Real Time Optimization (RTO) of compressors in chemical plants - An industrial case study. *Applied Energy*, *144*, 51–63. https://doi.org/10.1016/j.apenergy.2015.01.010

Xenos, D. P., Kopanos, G. M., Cicciotti, M., & Thornhill, N. F. (2016). Operational optimization of networks of compressors considering condition-based maintenance. *Computers and Chemical Engineering*, *84*, 117–131. https://doi.org/10.1016/j.compchemeng.2015.08.008

Xenos, D. P., Lunde, E., & Thornhill, N. F. (2016). Optimal operation and maintenance of gas compressor stations: An integrated framework applied to a large-scale industrial case. *Journal of Engineering for Gas Turbines and Power*, *138*(4). https://doi.org/10.1115/1.4031307

Zakiah, D., Hidayat, A., & Abdurohman, B. S. (2022). Optimization of the Air Compressor to Get Good Compressed Air In MV. Dewi Amabarwati. *Dinasti International Journal of Education Management And Social Science*, *4*(1), 96–103.

Zhou, D., Zhou, K., Zhu, L., Zhao, J., Xu, Z., Shao, Z., & Chen, X. (2017). Optimal scheduling of multiple sets of air separation units with frequent load-change operation. *Separation and Purification Technology*, *172*, 178–191. https://doi.org/10.1016/j.seppur.2016.08.009