

ANALYSIS OF FACTORS CAUSING AIR POLLUTION ON SHIPS

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ABSTRACT

Air pollution on ships is a serious problem that can affect human health, the environment, and the operational safety of the ship itself. The aim of this study is to identify and understand the factors that contribute to air pollution on ships, as well as provide a better understanding of its impact on human health and the environment. This study used the research method of literature review. Data collection techniques are carried out by literature studies, data obtained through Google Scholar. The results showed that poor air quality inside the ship can be caused by exhaust emissions from the engine, inefficient fuel use, the presence of an inadequate exhaust gas separation system, shipping in traffic-heavy areas or routes often used by large ships, fuel combustion processes, and weather factors. The impact of air pollution on human health includes respiratory disorders, cardiovascular disorders, to skin health problems. While the impact on the environment includes air pollution in the port area, water pollution, and soil pollution.

Keywords: *Pencemaran, Udara, Kapal*

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INTRODUCTION

Air pollution has become one of the major global environmental issues of concern around the world. According to a survey conducted by the World Health Organization (WHO) in 2002, in 1,600 cities spread across 91 countries, almost 90% of residents in urban centers breathe unhealthy air (Mursinto & Kusumawardani, 2016). There are several sources of air pollution, one of which comes from ships. Air pollution on ships is a serious problem that can affect human health, the environment, and the operational safety of the ship itself. According to data presented by the databox, air pollution caused the most deaths in Indonesia in 2017. The number of deaths due to pollution reached 123.8 people. While the second position is occupied by water pollution (Aeni, 2021). Some of the most commonly found types of air pollution are Carbon Monoxide (CO), Nitrogen Oxides (NO₂), Sulfur Oxides (SO_x), Photochemical Oxides and Particles (Ministry of Health, 2019).

Ships are a source of air pollution that contributes significantly to air pollution, which comes from exhaust emissions in the form of: NO_x, SO_x, Particulate Matter, CO and CO₂ (Samosir et al, 2017). In research (Rohmatulloh et al, 2018) the exhaust emissions produced are above the threshold. The threshold set for potentially polluting air quality is 12.51. However, based on the calculations made, the emission results exceeded this threshold, with the amount reaching 61.09055556 and so did the calculation results for other parameters. These results indicate the potential for significant air pollution from the vessels studied.

Previous research conducted by Sudrajad in (Abadi & Pristiam, 2018) stated that most, about 90%, of nitrogen oxide (NO_x) emissions are generated through the thermal NO_x process, and it is known that the use of HFO (Heavy Fuel Oil), which is a common fuel used in ships, contributes around 20-30% of NO_x emissions. Nitric oxides present in the air we breathe can cause damage to the lungs. After reacting with atmospheric components, this substance forms very fine nitrate particles and can penetrate the deepest parts of the lungs. In addition, when

nitrogen oxides react with completely unburned gasoline fumes and other organic chemicals, low ozone or smog-brown haze forms that envelops many cities around the world.

The importance of understanding the factors that contribute to air pollution on ships attracts the attention of researchers, besides that the absence of specific research discussing the factors that cause air pollution on ships is the novelty of this study. The aim of this study is to identify and understand the factors that contribute to air pollution on ships, as well as provide a better understanding of its impact on human health and the environment.

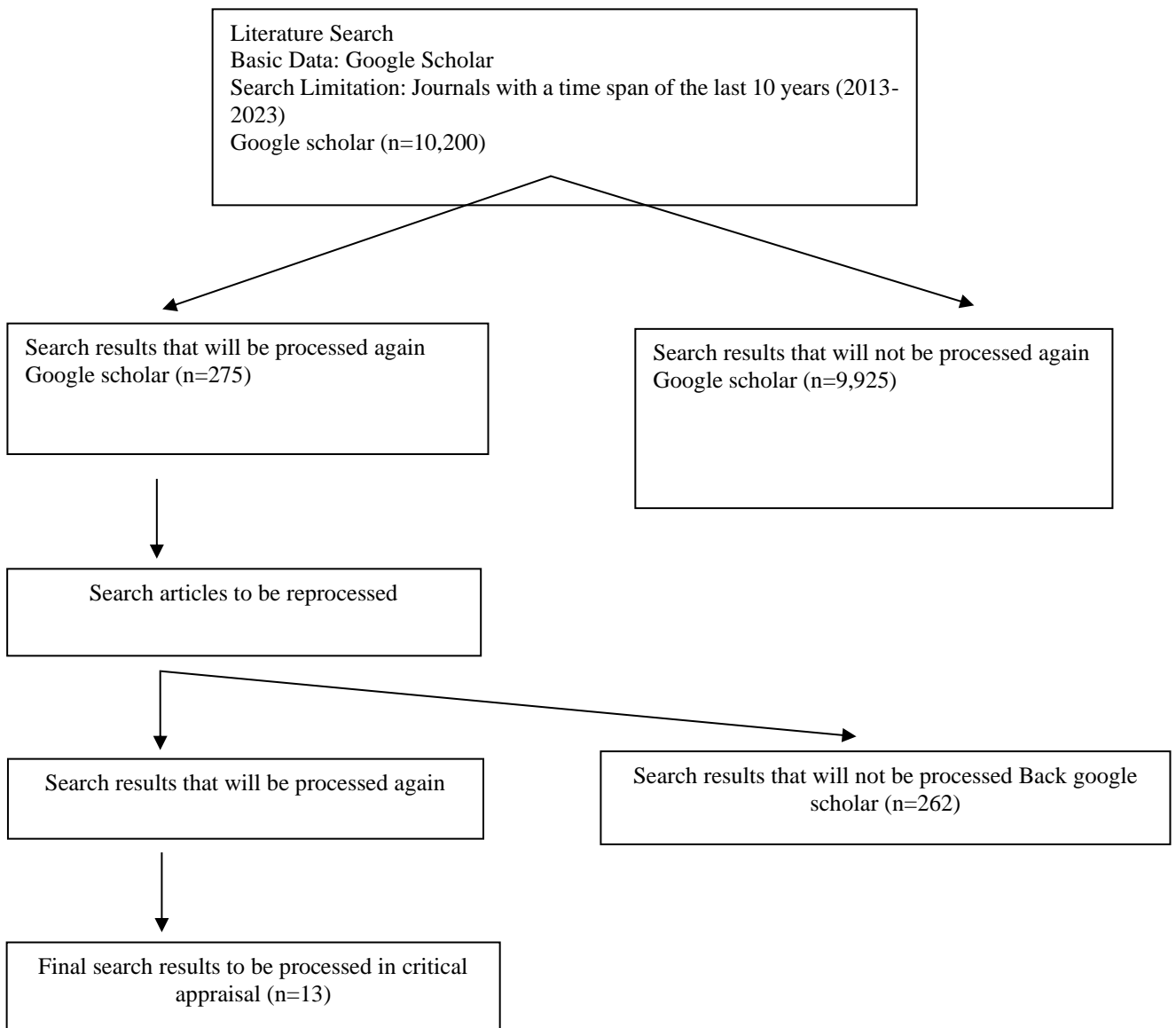
METHOD

This study used the research method of literature review. According to Hasibuan, in (Syafnidawaty, 2020) literature review contains a description of theories, findings and other research materials obtained from reference materials to be used as a basis for research activities. The description in this literature review is directed to compile a clear framework of thinking about problem solving that has been described in the previous on problem formulation. Data collection techniques are carried out by literature studies obtained through Google Scholar. The selected data sorted by inclusion and exclusion criteria include:

Table 1. Inclusion and Exclusion Criteria

No	Inclusion Criteria	Exclusion Criteria
1	Journal, Book or Web Indonesian or English	Journals, Books or Web other than Indonesian and English
2	The journal will be published in the period 2013-2023	Journal published before 2013 period
3	The contents of Journals, Books or Web are relevant to research	The content of Journals, Books or Web is not relevant to the research

The sorted data obtained as many as 13 studies that are relevant to the factors causing air pollution on ships and will be discussed in this study.



RESULTS AND DISCUSSION

Data including the inclusion of this study, obtained the following results:

Table 2. Research Data Summary

No	Author and Year	Heading
1	Fiennes, Ranulph. (2017).	Ban on the Use of Heavy Oil in the Arctic.
2	Ministry of Health of the Republic of Indonesia (Kemenkes). (2019).	The impact of air pollution (air pollution) on hypertension.
3	Lorenza, L. (2017).	Co-gasification of wood and coal waste downdraft system in terms of the effect of fuel comparison to syngas.

4	Nazikhah, A., & Disrinama, A. (2017).	Analysis of Factors Influencing Lung Function Disorders in Shipyard Companies (Case Study of PT. X).
5	Rahmadani, Fara. (2023).	Heavy Fuel Oil: Meaning, Density, Price, and Components.
6	Saidal Siburian, M. M., & Mar, M. (2020).	Air Pollution and Greenhouse Gas Emissions.
7	Sugiarti. (2009).	Air polluting gases and their effects on human health.
8	Widodo, S., Amin, M. M., Sutrisman, A., & Putra, A. A. (2017).	Design a microcontroller-based monitoring tool for clean air levels and harmful gases CO, CO ₂ , and CH ₄ in the room.
9	Budiarto, H., Umam, F., & Irawan, I. (2022).	Gasification: Theory, Design and Application.
10	Palebangan, H. (2019).	Analysis of LNG-Fueled Ships as Marine Fuel in Reducing Exhaust Emissions on Ship Traffic at Bitung Port.
11	Rizqi, A. (2021).	Air Quality Analysis for Nh ₃ Parameters on Median Arterial Roads in Makassar City
12	Awaluddin, A. (2016).	Public health complaints due to haze from forest and land fires in Pekanbaru City.
13	Budhiawan, A., Susanti, A., & Hazizah, S. (2022).	Analysis of the Impact of Environmental Pollution on Social and Economic Factors in Coastal Areas in Bagan Kuala Village, Tanjung Beringin District, Serdang Bedagai Regency.

PEMBAHASAN

Factors Causing Air Pollution

The main factor causing air pollution on ships is the use of fuels that are not environmentally friendly, such as Heavy Fuel Oil (HFO). HFO is a type of fuel commonly used in marine vessels. This fuel is preferred because of its low price and high viscosity compared to other types of fuel. HFO is a heavy fuel oil derived from refining crude oil. Its characteristics require it to be stored at high temperatures. Although the combustion of heavy fuel oil produces high emissions of pollutants such as nitrogen oxides (NO_x), sulfur oxides (SO_x), and carbon dioxide (CO₂) in exhaust gases (Rahmadani, 2023), these fuels are also toxic and environmentally unfriendly (Fiennes, 2017).

According to research conducted by Schlesinger and William in (Sugiarti, 2009) about 90% of nitrogen oxide (NO_x) emissions are caused by the thermal NO_x process. Data also shows that the use of Heavy Fuel Oil (HFO), which is a common fuel used in ships, contributes about 20-30% of total NO_x emissions. Exposure to nitrogen oxides in the air inhaled by humans can cause lung damage. Having reacted with atmospheric components, this substance forms very fine nitrate particles and can penetrate into the deepest parts of the lungs. In addition, these oxides of nitrogen can also react with incompletely unburned gasoline fumes and other

hydrocarbon substances, producing the low ozone or smog-brown haze that often covers most cities in the world.

The process of burning fuel in ship engines plays an important role in creating air pollutants. When fuel is burned in an engine, a chemical reaction occurs that produces exhaust gases. However, combustion is not always complete, and this can lead to the emission of pollutants that are harmful to air quality. One of the pollutants produced is carbon monoxide (CO). CO is a toxic gas produced by incomplete combustion and can be harmful to humans if inhaled in large quantities (Widodo et al, 2017). Another pollutant is nitrogen oxides (NO_x), which consist of nitrogen monoxide (NO) and nitrogen dioxide (NO₂). NO_x is formed when nitrogen in the air reacts with oxygen and heat generated by combustion. These pollutants can also have adverse impacts on human health and contribute to ozone formation and air pollution (Lorenza, 2017). In addition, the incomplete combustion process also produces small particles known as particulate matter (PM). These particles consist of various substances, such as dust, soot, and metal particles. PM has a very small size so that it can be easily inhaled and enter the human respiratory system. These particles can cause respiratory problems, irritation of the respiratory tract, and even potentially cause serious illness in the long term (Saidal & Mar, 2020).

The presence of an inadequate or improperly functioning exhaust gas separation system can be a factor in increased emissions of air pollutants from ships. Exhaust gas separation systems, such as scrubbers or other devices, are designed to remove or reduce the pollutant content in the exhaust gas before it is released into the atmosphere. If the exhaust gas separation system is inadequate, meaning it is unable to cope with the amount or type of pollutants produced by the vessel, then the emission of pollutants such as NO_x, SO_x, CO, and PM may increase. For example, if the scrubbers on a ship are not functioning properly, the exhaust gases released into the air may still contain high levels of pollutants, such as sulfur dioxide (SO₂) or fine particulate matter (PM). In addition, failure to maintain and repair the exhaust gas separation system routinely can also lead to a decrease in system efficiency. This can result in increased pollutant emissions because the system cannot remove pollutants effectively (Budiarto et al, 2022).

Sailing in traffic-heavy areas or routes often used by large ships can cause an increase in air pollutants due to the emissions of ships that are close to each other. This phenomenon is known as the "cluster effect" or "ship convoy effect". When large ships sail in adjacent formations or follow similar routes, the amount of air pollutant emissions released into the atmosphere can increase significantly. This is due to the buildup of emissions from each ship in the group, so that the concentration of pollutants around the shipping area becomes higher. In addition, increased emissions of ships that are close to each other can also have an impact on the operational safety of the ship itself. High concentrations of pollutants can reduce visibility, increase the risk of accidents, and affect ship navigation (Palebangan, 2019).

Weather factors, such as wind speed and direction, air temperature, and humidity, play an important role in the dispersion of air pollutants around ships. These factors can affect the extent to which air pollutants released by ships will disperse and decompose in the atmosphere. Wind speed and direction have a direct influence on the dispersion of air pollutants. If the wind blows at a high speed and the direction is away from land or residential areas, air pollutants will be more easily dispersed and can spread evenly in the atmosphere. However, if the wind is blowing at low speed or towards land or residential areas, air pollutants tend to be trapped

and concentrated around the ship or in areas affected by the direction of the wind. In addition, air temperature and humidity also affect the dispersion of air pollutants. Warmer air tends to be more prone to vertical movement, so air pollutants can be more quickly dispersed vertically into higher layers of the atmosphere. Air humidity can also affect air pollutants because pollutant particles have the possibility to bind to water in the atmosphere and form larger particles, which can eventually fall to the ground surface (Rizqi, 2021). In addition to the ship itself, shipyard companies that serve several services with a scale of repair include *blasting* and painting (painting), replacing new **plates** (Replating) *for thick plates that are not in accordance with standards*, shafting and steering improvements based on the results of mechanical QC measurements, reconditioning valves for systems on ships, overhaul A / E and M/E also cause problems generated by the activity is air pollution and dust exposure (Nazikhah & Disrinama, 2017). In an effort to understand weather factors that affect the dispersion of air pollutants around ships, more effective efforts can be made to reduce the impact of air pollution and maintain air quality around shipping areas.

Impact of Air Pollution

The impact of air pollution on human health includes respiratory disorders, cardiovascular disorders, to skin health problems (Awaluddin, 2016).

1. Respiratory Disorders

Continuous exposure to air pollutants on ships, such as dust particles, toxic gases, and chemicals, can cause respiratory problems such as respiratory tract irritation, asthma, bronchitis, and chronic obstructive pulmonary disease (COPD).

2. Cardiovascular Disorders

Exposure to air pollutants in vessels containing fine particulate matter can increase the risk of heart disease and stroke in humans.

3. Skin Health Problems

Air pollutants present on ships, such as smoke and chemicals, can cause skin irritation, rashes, and other skin conditions.

Air pollution has an impact on health including respiratory tract disorders, heart disease, cancer of various organs, reproductive disorders and hypertension (high blood pressure) (Ministry of Health, 2019). In addition, air pollution also has an impact on the environment. Meanwhile, the impact on the environment includes air pollution in the port area, water pollution, and soil pollution (Budhiawan et al, 2022).

1. Air Pollution

Exhaust emissions from ships can cause widespread air pollution in the area around ports and waters. This can negatively impact regional air quality and the natural environment, as well as disrupt surrounding ecosystems and animal and plant life.

2. Impact on Water Quality

Air pollutants from ships can settle on the surface of the water and cause water contamination, especially if there are deposits of dust particles containing harmful chemicals.

3. Impact on soil quality

Dust and air pollutant particles from ships can settle in the soil around the port, causing soil pollution and disrupting soil fertility and plant growth.

The impact of air pollution on ships on human health and the environment is very important to note. Efforts needed to mitigate this impact include adopting more environmentally friendly

technologies to reduce exhaust emissions, improving ventilation systems on ships, ensuring good maintenance of engines and systems, and putting forward strict environmental policies in the shipping industry.

CONCLUSION

Poor air quality inside ships can be a serious problem affecting human health and the environment. Poor air quality inside ships can be caused by exhaust emissions from engines, inefficient use of fuel, the presence of inadequate exhaust gas separation systems, shipping in traffic-heavy areas or routes often used by large ships, fuel combustion processes, and weather factors. The impact of air pollution on human health includes respiratory disorders, cardiovascular disorders, to skin health problems. While the impact on the environment includes air pollution in the port area, water pollution, and soil pollution.

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