Journal of Vocational Health Studies

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EFFORTS IN CONTROLLING COAL DUST HAZARDS IN THE STOCKPILE AREA OF A STEAM POWER PLANT (PLTU)

UPAYA PENGENDALIAN BAHAYA DEBU BATU BARA PADA AREA STOCKPILE PERUSAHAAN PEMBANGKIT LISTRIK TENAGA UAP (PLTU)

Research Report
Penelitian

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ABSTRACT

Background: *The movement of coal or other activities in the stockpile area of a steam power plant can create a coal dust hazard or commonly referred to as respirable dust. The smaller the particle size, the more harmful effects it can have on human health, such as bronchitis, decreased lung function, Chronic Obstructive Pulmonary Disease (COPD), Coal Worker's Pneumoconiosis (CWP), and other respiratory diseases.* ***Purpose:*** *To study the chemical hazards of the working environment of coal dust and the control efforts conducted in the stockpile area of a steam power plant company.* ***Method:*** *This research was descriptive observational with a cross-sectional study. The data were comprised of primary data collected from interviews and observations, and secondary data such as environmental measurement report and documentations owned by company.* ***Result:*** *The results of the measurement of coal dust hazard in the stockpile are were 0.007 mg/m^3 and 0.063 mg/m^3 for personal dust measurements. Some of the coal-dust-hazard control efforts performed by PT. POMI included the installation of a spray gun, a dust suppression system, reforestation, and ventilation setting. Further, OHS induction was conducted, together with safety talk, working hour regulations, toolbox meeting, training on the use of PPE, Medical Check Up (MCU), person authorization, preventive maintenance, and the use of PPE by workers.* ***Conclusion:*** *The measurement of the coal dust hazard in the stockpile area is below the threshold value which is 3 mg/m^3 for respirable particles and 10 mg/m^3 for inhalable particles. PT. POMI has done several preventive and control efforts towards coal dust hazard, and there were no health problems found in workers.*

ARTICLE INFO

Received 13 June 2022
Revised 15 June 2022
Accepted 30 September 2022
Online 01 November 2022

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Keywords:
Control efforts, Coal dust, Steam power plant

ABSTRAK

Latar belakang: Perpindahan batu bara atau aktivitas lain di area *stockpile* Pembangkit Listrik Tenaga Uap (PLTU) dapat menghasilkan bahaya debu batu bara atau biasa disebut sebagai debu respirabel. Semakin kecil ukuran partikel dapat memberi efek lebih berbahaya terhadap kesehatan manusia, seperti bronkitis, penurunan fungsi paru, *Chronic Obstructive Pulmonary Disease* (COPD), *Coal Worker's Pneumoconiosis* (CWP), dan gangguan pernafasan lainnya. **Tujuan:** Mempelajari bahaya faktor kimia lingkungan kerja debu batu bara dan upaya pengendalian di area *stockpile* PLTU. **Metode:** Penelitian ini adalah penelitian deskriptif observasional studi *cross sectional*. Data diambil melalui wawancara, observasi, dan penggunaan data sekunder berupa laporan dan dokumentasi pengukuran lingkungan kerja milik perusahaan. **Hasil:** Hasil pengukuran kadar debu batu bara di lingkungan *stockpile* 0,007 mg/m^3 dan 0,063 mg/m^3 pada pengukuran debu personal. Pengendalian bahaya debu batu bara oleh PT. POMI adalah pemasangan *spray gun*, *dust suppression system*, penghijauan, dan pengaturan ventilasi. Selain itu, dilakukan induksi K3, *safety talk*, pengaturan jam kerja, *toolbox meeting*, pelatihan penggunaan APD, *Medical Check Up* (MCU), *person authorization*, *preventive maintenance*, dan penggunaan APD oleh pekerja. **Kesimpulan:** Pengukuran bahaya debu batu bara di area *stockpile* PLTU di bawah Nilai Ambang Batas (NAB) 3 mg/m^3 untuk partikel respirabel dan 10 mg/m^3 untuk partikel *inhalable*. PT. POMI telah melakukan beberapa upaya pencegahan dan pengendalian terhadap bahaya debu batu bara dan tidak ditemukan masalah kesehatan pada pekerja.

Kata kunci:
Upaya pengendalian, Debu batu bara, PLTU

Journal of Vocational Health Studies p-ISSN: 2580–7161; e-ISSN: 2580–717x
DOI: 10.20473/jvhs.V6.I3.2022.127-133

INTRODUCTION

According to Law of The Republic Indonesia Number 1 of 1970 which discusses work safety, workplace is any room or field, whether closed or open, moving or fixed, where the workforce performs their work. Work environment and processes can bring various hazards that can interfere with workers' safety and health, including physical, chemical, biological, ergonomic, and psychological hazards. The importance and obligation of implementing Occupational Health and Safety (OHS) to be performed out by companies is stated in Law of the Republic of Indonesia (1970) concerning Occupational Safety and Law of the Republic of Indonesia (2003) concerning Manpower, including the power generation business. Based on the elucidation of Law Number 13 of 2003, occupational safety and health efforts are intended to provide safety guarantees and improve the health status of workers and laborers by preventing accidents and occupational diseases, controlling workplace hazards, health promotion, treatment, and rehabilitation.

The Steam Power Plant (PLTU) company, which uses coal as the main raw material to generate electricity, has a coal storage area called a stockpile. The transfer of coal or other activities that take place in the stockpile area, such as the use of a stacker reclaimer, can cause coal dust to fly, which is harmful to the health of the workers who are exposed to it, as well as the surrounding environment. The operation of heavy equipment in the stockpile area can also increase the spread of dust in the work environment. Dust is a chemical substance in the form of a solid, produced from natural or mechanical forces such as displacement, crushing, processing, etc., both organic and inorganic, within diameter ranging from 0.1 to 500 microns (Merry Sunaryo *et al*., 2021).

Coal dust is commonly referred to as respirable dust with *Particulate Matter* 10 or PM 10 having a diameter of <10 microns and PM 2.5 with <2.5 microns of diameter (Thakur, 2018). PM 10 dust can reach the upper respiratory tract and can cause coughs, asthma, and bronchitis. Meanwhile, dust with a size of <2.5 microns can enter the lungs to the human bloodstream and pose a risk of cancer, heart attacks, and others. Thus, the smaller the particle size, the more harmful the effects on human health, especially on the respiratory organs. Based on the Presiden Regulation Number 7 of (2019) concerning occupational disease, coal dust is one of the causes of chronic obstructive pulmonary disease or COPD. Sugiharti and Sondari (2015) stated that based on the Indonesian Directorate General of Disease Prevention and Control, Chronic Obstructive Pulmonary Disease (COPD) ranks first as a contributor to the morbidity rate of 35%, followed by asthma (33%) and lung cancer (30%).

Coal dust is fibrogenic dust that can produce specific effects in the form of pulmonary interstitial tissue fibrosis, the formation of fibrous connective tissue, which can reduce the elasticity of the alveoli. As the results, the volume of air held by the alveolus decreases, then leads to pulmonary restriction. Long-term exposure to coal dust can cause several lung or respiratory tract diseases such as *Coal Worker's Pneumoconiosis* (CWP), *Progressive Massive Fibrosis* (PMF), chronic bronchitis, decreased lung function, and emphysema (Zhang *et al*., 2021). Black lung, asthma, COPD, silicosis, and cardiovascular disease can also occur as a result of long-term exposure to coal dust (Kollipara *et al*., 2014).

Until now, there is no specific treatment for the incidence of CWP. The only thing that can be done is to relieve the symptoms, reduce complications, and slow down the progression of the cell damage. Because the incidence of CWP is irreversible, workers with CWP will gradually lose their ability to work, reduce quality of life, and even lose life expectancy. Furthermore, it can increase the physical, mental, and economic burden for those who get affected and their families. PT. POMI itself has carried out measurements of the work environment including chemical factor such as coal dust every year. The results show that there is no coal dust content that exceeds the threshold value. However, Wulandari *et al*. (2016) stated that PM concentrations below the threshold value did not fully guarantee that exposed individuals were free from the risk of respiratory disorders. Moreover, PM's chronic effects depend on the frequency of exposure received by workers. Hence, it is important to prevent and control coal dust to avoid the occurrence of occupational diseases due to the coal dust. Therefore, researchers are interested in studying the hazard of chemical factors in the working environment, especially coal dust and the control efforts carried out in the stockpile area of *Paiton Operation and Maintenance Indonesia* (PT. POMI).

MATERIAL AND METHOD

The present study was descriptive observational with a *cross-sectional* study. It was conducted at PT. POMI Probolinggo Regency, East Java, Indonesia. Primary data related to coal dust conditions and control efforts undertaken were obtained through direct observation in the stockpile area and interviews involving *Health, Safety, Environment, Compliance* (HSE & C) and *Fly and Ash Department (*FA) as the department that handled all work activities related to coal, especially in the stockpile area. In addition, report and documentations toward the work environment owned by company were used.

RESULT

PT. POMI is one of the PLTU operators under the auspices of *Paiton Energy* (PE), providing electricity to Java and Bali areas with a capacity of 615 MW for units 7 and 8 and 800 MW for unit 3. In addition to the large amount of electricity generated, the demand for raw materials such as water and coal in the production process is also very high. To meet the demand for coal as a key component in the production process, unit 7 and 8 steam power plants bring coal from South Kalimantan via barges with a capacity of up to 43.000 tons, which are transshipped and then stored at coal plant or stockpile by using a jetty. The stockpile area of PT. POMI is divided into 4 areas. These are the active areas A, B, C and D as well as the inactive areas. The four areas can hold approximately 790 kt (kilo tons) or the equivalent of 790.000 MT (metric tons).

The stockpile area has two buildings that are used by workers to control the activities and operation of tools in that area such as stacker reclaimer, unloading process, transportation to the conveyor, conveyor control, and others. The two buildings are *Coal Unloading Control Building* (CUCB) and *Coal Handling Control Building* (CHCB). Almost all work activities in the stockpile area were controlled from the buildings, especially by CHCB. Workers that controlled activities in stockpile rarely and almost never worked locally and directly exposed themselves to coal. Steam power plant of PT. POMI as a national vital object that operated 24 hours, divided working hours into three work shifts. Each work shift consisted of eight hours of work and one hour of rest.

The process of coal mobilization activities could cause coal dust to fly and have an impact to the environment and the health of workers. PT. POMI measured coal dust in the work environment on regular basis. The measurement of coal dust, which is included PM 10, was carried out by the third parties. In 2021, PM 10 was measured by using the EPAM 5000 measuring instrument with the IAS-5.7.6-EN (direct reading) measurement method. The measurement results were then compared with the applicable regulation, which is Minister of Manpower Regulation Number 5 of (2018) concerning Occupational Safety and Health in the Work Environment. According to the regulation, the threshold value (TLV) for respirable particles is 3 mg/m^3 and 10 mg/m^3 for inhalable particles (Table 1).

Table 1. Results of air measurement in the working environment in the coal handling area of PT. POMI

Parameter test	Result	TLV
Dust Particulate <10µm (PM10)	0.007 mg/m^3	10 mg/m^3

Source: Environmental measurement report (2021)

Based on the Table 2, it is shown that the result of the PM 10 dust particulate measurement was 0,007 mg/m^3 using the IAS-5.7.6-EN (Direct Reading) measurement method. This figure was below the TLV for inhalable particulates based on the Minister of Manpower Regulation Number 5 of 2018, which was 10 mg/m^3. Another measurement was carried out on respirable particulates, namely PM 2.5 with a personal dust sampler and the following results were obtained.

Table 2. Measurement results of respirable particulates in coal handling workers

Worker name	Result	TLV (Permenaker 5/18)
A (coal handling)	0.063 mg/m^3	3 mg/m^3
B (coal handling)	0.063 mg/m^3	3 mg/m^3

Source: Environmental measurement report (2021)

The measurement of respirable particulates carried out on the two coal handling workers above showed that the results of exposure to coal dust were less than the determined TLV, which was 0.063 mg/m^3 from the TLV of 3 mg/m^3. Other measurements were also carried out to see the *Indoor Air Quality* (IAQ) of buildings located in the stockpile area, namely the CHCB. The results of the measurement of O_2 levels were 20.9% (TLV=19.5% – 23.5%).

DISCUSSION

In Indonesia, it is stipulated in the Minister of Manpower Regulation Number 5 of (2018) that the TLV for respirable dust is 3 mg/m^3. The TLV is the same as what is determined by American Conference of Governmental Industrial Hygienists (2021). Furthermore, the TLV of coal dust by type is 0.44 mg/m^3 for anthracite and 0.9 mg/m^3 for bituminous or lignite type. Colinet *et al*. (2010) sets the TLV for coal dust at 1 mg/m^3 for 10 hours of work a day or 40 hours a week. Mine Safety and Health Administration (2020) set a respirable coal dust standard of 2.0 mg/m^3 (<1% quartz) in bituminous type.

The results of measurements made by PT. POMI involving the third party showed that the levels of coal dust in the stockpile environment that could be inhaled by workers were below the recommended threshold value. Wulandari *et al*. (2016) stated that PM concentrations below the threshold value do not fully guarantee that exposed individuals are free from the risk of respiratory disorders. It is because PM's chronic effects depend on the frequency of exposure received by workers. Research conducted by Simanjuntak (2015) indicated workers who were exposed to high levels of dust were 7.2 times more likely to experience pneumoconiosis. The results of the health examination or *Medical Check Up* (MCU) conducted by PT. POMI, both annually and specially, did not show any health problems or complaints as a result of coal dust exposure, especially workers in the stockpile area.

There are factors that influence the occurrence of occupational disorders or diseases on the respiratory tract caused by dust, specifically including particles, concentration, shape, chemical properties, and duration of exposure (Thakur, 2018). In addition to work environment factors that contain the danger of coal dust, several other factors can risk an individual in experiencing disorders of the respiratory system, namely the individual characteristics and behavior of workers in the work environment. Individual factors include age, gender, and level of education. While work behaviors include smoking habits and the use of respiratory protective equipment or personal protective equipment. Suma'mur (2009) asserted that individual factors in the form of defensive mechanisms or lung strength, anatomy and physiology of the respiratory tract can also affect respiratory disorders that may be experienced.

According to Ding *et al*. (2020), spray dust fall, chemical dust suppression, dust collector removal, coal seam water injection and *Personal Protective Equipment* **(**PPE) are very efficient dust control and protection methods. PT. POMI itself has made several efforts to control the coal dust hazard in the workplace. Some of these control efforts, especially in the stockpile area of PT. POMI, were based on the *Occupational, Health, and Safety* (OHS) hierarchy of control by *The National Institute for Occupational Safety and Health* (NIOSH) (2015)

Elimination

Elimination is a control effort by eliminating the source of the hazard. The danger of coal dust comes from coal, which is the main raw material in the steam power plant production process. Thus, it is impossible to control coal dust by means of elimination.

Substitution

Elimination control efforts that cannot be carried out also apply to substitution control efforts. Coal as a key material in the steam power plant production process cannot be replaced with other resources.

Engineering

Installations of spray gun

The following picture is of a spray gun that was placed around the stockpile area at PT. POMI. The spray gun was useful for reducing flying dust from coal activities in the stockpile area (Fig. 1). It worked by spraying water into dusty areas.

Figure 1. Spray gun in the stockpile area of PT. POMI

The spray gun was manually operated by a valve as needed. Previously, it had been made to work automatically, so that all spray guns could work simultaneously with one control. However, it turns out the water pressure is not enough, so the range of the spray gun cannot be far. Thus, the spray gun is operated manually to make it more optimal. Spray gun or spray nozzle should be operated at high pressures to produce smaller droplets and move more air (Beck *et al*., 2018). At PT. POMI, the spray gun was around the stockpile except the west side. Apart from being around the stockpile, there were also spray guns along the stacker reclaimer every 10 meters, and PT. POMI had a total of two reclaimer stackers.

Procurement of dust suppression system

Another coal dust control in the stockpile area was the provision of a dust suppression system. Dust suppression in the stockpile area was located on the bucket wheel of stacker reclaimer. PT. POMI had two stacker reclaimers, so in total there were two dust suppression systems in the stockpile area. The following was a stacker reclaimer in the stockpile area of PT. POMI (Fig. 2).

Figure 2. Stacker reclaimer PT. POMI

In addition, there were dust suppression systems placed in transfer house at each end of the conveyor. The dust suppression system is located in each shaft in the transfer house. There were two types of dust suppression systems used by PT. POMI, namely dust suppression system that operated automatically when a carbon load was detected, and dust suppression system that was manually operated and controlled by an operator in the CHCB. Dust suppression used by PT. POMI sprayed water in the form of mist to control coal dust. According to the interview results, dust control in the form of mist was considered to be more effective in controlling the dust, but because of the complicated use and the high price, PT. POMI preferred to use a water-based dust suppression system.

Besides the dust suppression system, the dust collector was another method of coal dust control. The dust collector was located in the crusher area. It sucked up the flue dust when crushing pulverized coal in the crusher, and then returned it to the conveyor. It is also used as an alternative as the coal could not get wet.

Reforestation of stockpile area

Reforestation by planting trees is an alternative solution that can help reduce dust pollution due to coal activities. Besides being able to produce oxygen, reforestation can absorb pollutants through its leaves (Azzahro *et al*., 2019). The Figure 3 shows the reforestation conditions carried out by PT. POMI.

Figure 3. Reforestation in the stockpile area of PT. POMI

In the stockpile area of PT. POMI, various types of vegetation or green plants were planted as an effort to control coal dust. The vegetation included white teak (*Gmelina arborea*) and neem or neem leaves (*Azadirachta indica*).

Indoor ventilation setting

In the stockpile area, there was a building that controlled almost the entire work process. The building was named CUCB to regulate the process of unloading coal and the CHCB to control coal handling process. The buildings were designed to be tightly closed to protect workers from coal dust exposure while still paying attention to ventilation in the room. Efforts to regulate ventilation carried out by PT. POMI were to use an *Air Conditioner* (AC) and a hepafilter in the room. Air conditioner has been defined with four basic functions; those were temperature regulation, humidity control, air circulation and/or ventilation, and air purification or filtration (Centnerova, 2018). In addition to the building, the heavy equipment cabin was also designed to be airtight with an air-conditioner in it.

Administrative control

Safety induction or OHS induction and specific OHS induction

Visitor and new workers who wanted to enter the work area and began to work were given a general OHS induction and would receive additional special OHS induction, in this case, before working in the stockpile area. The special OHS induction was given by the Fuel and Ash Department PT. POMI as the person in charge of the stockpile area. Specific OHS induction in more details provided information related to work areas, work processes, occupational safety and health hazards that may be encountered, and others.

Health and safety talk

Health and safety talk was done regularly once a month. The aim of this health and safety talk was to remind workers about the hazard that existed in the work environment. Therefore, they would stay aware of the hazard they faced and could take preventive actions. The health and safety talk was also conducted if there were new work processes, work tools, or work materials, which means there were also new hazard that may arise.

Toolbox meeting

Toolbox meeting at PT. POMI was carried out to ensure that the work was ready to be carried out with the requirements that had been fully met. Also, it ensured that the hazards that existed in the workplace were known by the workers and showed that control efforts had also been carried out together with the emergency response procedures.

Working hours regulation

Coal handling workers in the stockpile were divided into three work shifts. Morning shift started from 07.00 to 15.00, afternoon shift started from 15.00 to 23.00, and night shift started from 23.00 to 07.00. Each work shift consisted of eight hours of work and one hour of rest. Almost all of the coal handling workers worked inside the building, namely at CHCB. They worked locally in the field and had direct exposure to the hazards of coal dust only occasionally and in short duration if required. Most of the time, they were not in field during full shift work hours. The longer workers are in the workplace and exposed to chemicals, the higher the potential dose was received by the workers (Reese, 2017). Dosage is determined based on exposure time and quantity of chemical exposed. In this case, dosage determines the severity experienced by exposed workers.

Training on PPE

PPE provided and required by PT. POMI for workers in the stockpile area included N95 masks and cartridge respirators. Before starting work, workers were given training to use the PPE properly, so that PPE could work optimally to protect workers from coal dust. Moreover, the correct use of PPE could make workers more comfortable using it. The existence of strict regulation against PPE used in workplace and safety induction as a process of information dissemination could be a contributing factor for workers using PPE. That was in accordance with the result of a previous study conducted by Rofifa *et al*. (2019), about the use of PPE in laboratory workers.

PT. POMI carried out MCU annually. Examinations received by each worker were adjusted to the type of work and the health risks that might arise from their work. Workers who were exposed to the coal dust hazard, including workers who worked in the coal handling stockpile area, were examined for lung function or its physiology using spirometry. Spirometry itself can show person's lung volume capacity, so it can detect the occurrence of obstruction, restriction, or both. However, spirometry cannot show the specific cause of the pulmonary function disorders that occur (Harianto, 2010). Based on the results of the MCU that had been carried out by PT. POMI, no complaints or occupational diseases were found from exposure to coal dust. However, this spirometry examination was not carried out during the COVID-19 pandemic as an effort to break the chain of COVID-19.

Authorization person

Policy of authorization person that applied at PT. POMI was an effort to protect workers from occupational safety and health hazards. Person authorization means restricting access to the work area. Workers who were allowed to enter the work area were required to have followed the OHS induction and knew the safety and health hazards in the related work area, in this case the coal handling stockpile area. So that workers could take preventive measures against occupational safety and health risks such as using N95 masks or cartridge respirators. In addition, person authorization made it easier to determine the health checks that had to be carried out on workers exposed to coal dust.

Preventive maintenance

Preventive maintenance was carried out by periodic inspection of work tools in the stockpile area, such as stackers, reclaimers, dozers, conveyors, and others, including coal dust control tools (spray gun and dust suppression system). Inspections were carried out to ensure that work tools were functioning properly and repairs could be carried out early if damage was found. Maintenance and reparation of the spray gun and dust suppression system were carried out by the Maintenance Department of PT. POMI on *Work Order* (WO) FA Department. The maintenance activities were scheduled every three months.

PPE

PT. POMI carried out the use of PPE by providing N95 masks and respirator cartridges to protect the inhalation organs, and long-sleeved clothes to protect the skin. In the work place, the main routes of toxicants exposure occur through inhalation and skin contact (Kurniawidjaja *et al*., 2021). According to Faisal and Susanto (2017), N95 masks can filter PM with a size of 0.3 µm by 95%. Meanwhile, coal dust was included in PM 10 and PM 2.5 so that the use of N95 as PPE against the coal dust hazard could be considered quite effective with a note, awareness and sustainability efforts are needed from workers, such as wearing PPE with discipline and good management efforts namely PPE training, as well as regulation (Colinet *et al*., 2010).

CONCLUSION

PT. POMI, with the help of the third party, measured the state of coal dust in the work environment and personal dust exposure. From those measurements, it was determined that all measurement results were below the threshold value, which was 3 mg/m^3 for respirable particles and 10 mg/m^3 for respirable particles recommended by Minister of Manpower Regulation Number 5 of (2018). There were no health problems found among workers in the stockpile area due to the coal dust exposure. Some of the coal-dust-hazard control efforts performed by PT. POMI, especially in the stockpile area, involved the installation of a spray gun; the procurement of a dust suppression system; reforestation of the stockpile area; and ventilation setting. In addition, administrative control was carried out with occupational health and safety induction, safety talk, working hour regulations toolbox meetings, training on the use of PPE, medical check-up (MCU), person authorization and preventive maintenance. Workers in the stockpile area were also provided and required to use an N95 mask or respirator cartridge and long-sleeved clothes as PPE.

ACKNOWLEDGMENTS

Acknowledgments are addressed to Universitas Airlangga and PT. POMI that made important contributions in the implementation of research (lenders, data source providers, research materials, research facilities, and others), but not a team of writers. The authors state there is no conflict of interest with the parties involved in this study.

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