Work Accident Reduction Strategies With Job Safety Analysis at the Gum Rosin and Turpentine Factory

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ABSTRACT

The production methods at the Gum Rosin and Turpentine XYZ Factory involve several types of machinery and chemicals that might result in workplace accidents. Although the most recent Job Safety Analysis (JSA) was completed in 2018, various changes in work responsibilities have resulted in complaints from melting station workers in the case of eye irritation caused by turpentine vapor exposure and PGT waste workers as having the possibility of splashes from industrial waste. The purpose of this research is to assemble the most recent JSA document to eliminate potential dangers. This research was organized into four parts. The first stage involves conducting firsthand observations to describe the workers' responsibilities at each station. The second step includes interviewing the HSE staff and supervisors to determine the possible dangers of each operation. The third stage involves consulting with the HSE supervisor to decide on precautions to minimize possible dangers. The fourth stage consists of collecting JSA papers for each station. A total of 18 job descriptions with four categories of hazards were discovered based on the assembled JSA, including physical, chemical, mechanical, and ergonomic risks. Workplace safety recommendations here include the placement of safety signs, the installation of guardrails for waste tanks, and the application of personal protective equipment. A risk assessment to classify the risk level of each type of hazard and implementation of the JSA can be applied for future research.

Keywords: Job safety analysis, occupational health and safety, gum rosin and turpentine factory, potential hazard.

1. Introduction

The Gum Rosin and Turpentine XYZ Factory is a chemical industry which produces gum rosin and turpentine from raw materials in the form of pine resin. The specialty of pine trees is that they produce pine resin which is can further processed and has a high economic value (Suwaji et al., 2017). Muliani (2014) stated that the pine resin produced by pine, namely gum rosin and turpentine are used in the batik industry, plastics, soap, printing ink, varnish materials, and so on, while turpentine is used as a paint solvent (Suwaji et al., 2017).

During the operation of the Gum Rosin and Turpentine XYZ Factory, occupational safety and health (K3) is implemented to protect the workers. One of the efforts to maintain the safety and health of workers is to conduct safety briefings every time they start shift work. According to the ILO/WHO, OSH is an effort to maintain and improve the highest degree of physical, mental and social well-being for workers in all occupations, prevent health deviations among workers caused by working conditions, protect workers at work from the consequences of environmental factors. which is detrimental to the health, placement and maintenance of workers in a work environment that is adapted to physiological and psychological capabilities, as well as adjustments to human work and each human position (Irzal, 2016). According to the ILO and WHO in 1995, the objectives of OSH are the promotion and maintenance of physical, mental and social health of workers, prevention of health problems caused by working conditions, protection of workers from the risk of factors that interfere with health, placement and maintenance of workers in the environment. work in accordance with their physical and

psychological abilities, and the adjustment of each person to his work (Widodo, 2021).

The pine resin processing carried out by The Gum Rosin and Turpentine XYZ Factory involves many machines and chemicals that have the potential to cause work accidents. Referring to the ILO press release on 17 September 2021, the ILO and WHO estimate that almost two million people die from occupational diseases and accidents, this can reduce productivity, burden the health system, and have an impact on work income (Biro Humas Kemnaker, 2021). According to the ILO in 1996, work accidents are events arising from or in the course of work that result in fatal work-related injuries and non-fatal work injuries (Sultan, 2019). Meanwhile, according to Permenaker No. 11 of 2016, work accidents are accidents that occur in work relationships, including accidents that occur on the way from home to work or vice versa and diseases caused by the work environment (Sultan, 2019). Work accidents can be caused by hazards that have the potential to occur in the work being carried out. A hazard is something that can cause injury to people or damage to equipment or the environment. Several types of hazards that can be identified in the workplace are chemical hazards, physical hazards, ergonomic hazards, biological hazards and psychological hazards (Sumarna et al, 2018).

The Gum rosin and Turpentine XYZ factory conducted the latest work safety analysis in 2018 using Job Safety Analysis (JSA) and has not focused on the work of workers in the gum rosin and turpentine production process at each work station. Until now, there has been a change in the operator's duties, but no work safety analysis has been updated. This has led to the emergence of complaints submitted by workers, some of which are sore eyes due to exposure to turpentine vapor at the melter work station and the potential for splashing like factory waste at the PGT waste work station. Job Safety Analysis (JSA) helps to ensure that all members of the organization can recognize and understand actual or potential hazards, associated risks, appropriate actions, and controls needed to reduce potential injury or loss and protect themselves (Crutchfield & Roughton, 2016).

There have been many studies that use JSA and state the benefits of having a JSA document. JSA applied to PT. Geoservices Sangatta has succeeded in reducing the number of work accidents (Selvi Sampe, 2021). PT Pura Barutama experienced a decrease in cases after implementing hazard risk control with JSA (Prasetyo & Mirnayanti, 2017).

Making a JSA involves three steps, namely detailing the work steps from the beginning to the completion of the work, identifying hazards and potential work accidents based on predetermined work steps, and determining control measures based on the hazards in each work step. (Wahyudi, 2018). In addition to health and safety purposes, a JSA can also help product quality improvement program by reducing potential human errors (Ghasemi et al., 2023).

JSA document will be better if implemented directly afterward. this can make it easier for supervisors to provide training and efficient working instructions and warnings of potential hazards in work and can be used to review or re-learn if an accident occurs. With the JSA, operators can work safely and know the hazards that exist in work, how to control measures, and can increase knowledge and awareness of the importance of workplace safety. (Selvi Sampe, 2021).

The aim of this research is construct Job Safety Analysis (JSA) document in order to identify the potential hazard and determine the precautions to minimise the potential hazard happens for each of the six workstations. The workstations are gutter station, melting station, scrubbing station, cooking station, canning station, and PGT waste station.

2. Methodology

There are two types of data used in this study, namely primary and secondary data. The primary data used in this study were obtained through interviews, observations, and consultations with the workers of The Gum Rosin and Turpentine XYZ Factory and the Health Safety Environment (HSE) supervisor. Meanwhile, the secondary data used is the Standard Operating Procedure (SOP) document that applies at The Gum Rosin and Turpentine XYZ Factory, to be precise at all stations, namely gutter station, melting station, scrubbing station, cooking station, canning station, and PGT waste station.

The design of this research is qualitative, namely in the form of a narrative that mentions job descriptions and identification of hazards and control of hazards found at work stations at The Gum Rosin and Turpentine XYZ Factory. The research step begins by describing the work at all stations, identifying the hazards in each job description, and determining preventive measures for each hazard at each station. There are six stations, namely the gutter station, melting station, scrubbing station, cooking station, canning station, and PGT waste station.

Hazard identification is carried out using the Job Safety Analysis (JSA) form. The JSA form contains the company name, date of making, working station, detailed work steps, hazard potential in each step, and its prevention. The work steps were obtained from job description in the Standard Operating Procedure (SOP) at each station and detailed through observation.

Determination of hazard prevention efforts is carried out by identifying PPE that can protect the body parts that face directly to the hazard and checking the Material Safety Data Sheet (MSDS) for hazardous substances that can cause harm and also interviewing workers and the Health Safety Environment (HSE) Supervisor. The Job Safety Analysis (JSA) sheet is the output of the research that has been done.

3. Results and Discussion

3.1. Production Process

The production process carried out at The Gum Rosin and Turpentine XYZ Factory includes six stations, namely the gutter station, melting station, scrubbing station, cooking station, canning station, and PGT waste station.

The production process of gum rosin and turpentine consists of several stages. First, the pine resin that is in the pine resin tub is put into a gum gutter of a maximum of 2,500 liters. After the gutter is filled, oxalic acid is added as much as 0.2% of the amount of pine resin to bind the minerals that contaminate the pine resin. Next, the pine resin from the gutters is put into a melter tank to dilute the pine resin with turpentine as much as 30-40% of the pine resin. In addition to turpentine, this process also requires steam from the boiler to assist the dilution process as well as agitation of the pine resin and turpentine so that it is evenly mixed. In the melter, coarse dirt is also separated from the pine resin called litter. Litter is removed manually after 2-3 times the dilution process.

The liquid pine resin resulting from the melter process is put into the scrubber tank for cleaning the pine resin. In the scrubber, the washing and stirring process is carried out. Hot water as much as 700 kg was added in this process to dissolve the fine impurities that are still bound. After stirring, a deposition process is carried out to form two layers in the form of water and dirt and oil in the form of a mixture of gum and turpentine. Then the water blowdown. Do a test on the soft rosin to get a color less than 4.8.

Soft rosin is flowed into the holding tank before flowing into the cooking tank. After the capacity of the pine resin in the holding tank matches the capacity of the cooking tank, the pine resin is flowed into the cooking tank for cooking. The cooking process produces gum rosin and turpentine. Gum rosin is then put into a can and the turpentine is put into a turpentine storage tank.

Waste from the melter, scrubber, storage tank, and cooking processes is channeled to PGT Waste. The waste generated is water, jonjot, and OPR. Jonjot and OPR produced by Factory 1 are then separated with turpentine. Jonjot that has been separated is processed again by the black gondo cook to become black gondo. The clean wastewater is sent to the WWTP (Wastewater Treatment Plant). Meanwhile, the OPR is put into the OPR holding tank.

3.2. Job Description

Based on the SOP applied and observations at all stations, job descriptions were obtained for all stations.

a. Gutter Station
   In gutter, the operator turns the steering wheel to open the pine resin tub cover so that the pine resin enters the gutters.
b. Melting Station
   1. Push the pine resin into the melter tank.
   2. Turning the steering wheel to open the flow of pine resin from the gutters to the melter, inserting turpentine, stirring and heating processes, and flushing litter.
   3. Open the litter flow cover to remove the litter.
   4. Unloading the litter.
c. Scrubbing Station
   1. Turning the steering wheel to open the flow of pine resin from the melter to the scrubber, stirring, adding hot water, and settling.
   2. Taking samples of soft rosin.
d. Cooking Station
   1. Turn the steering wheel to control the cooking process.
   2. Taking gum rosin samples to be tested in the laboratory.
e. Canning Station
   1. Prepare gum rosin cans and pallets and check and repair cans if they are dented.
   2. Number the cans with spray paint.
   3. Put the can on the pallet.
   4. Put pallets and cans on the scales with a forklift.
   5. Open the gum rosin tap and fill the gum rosin can according to capacity.
   6. Move the cans containing gum rosin to a place that has been prepared with a forklift.
   7. Close the can of gum rosin while waiting for all the cans to be filled.
   8. Move all cans containing gum rosin to the place provided by the forklift.
f. PGT Waste Station
   Pushing waste water, bulge, OPR to enter the next tank with the help of a water push stick.

3.3. Potential Hazard

There are possible risks discovered during the execution of work in all stations by workers in all stations. Table 1 depicts the potential dangers and categories of hazards associated with gutter work. Table 2 depicts the potential dangers and categories of hazards associated with melting work. Table 3 depicts the potential dangers and categories of hazards associated with scrubbing work. Table 4 depicts the potential dangers and categories of hazards associated with cooking work. Table 5 depicts the potential dangers and categories of hazards associated with canning work. Table 6 depicts the potential dangers and categories of hazards associated with PGT waste work.

Table 1. Potential Dangers and Categories of Hazard Associate with Gutter Work

Categories of Hazard	Potential Hazard
Physical Hazard	Falls from a height
Chemical Hazard	Eye irritation caused by steam vapor exposure
	Respiratory burn caused by steam vapor aspiration
	Skin burn caused by steam vapor exposure
Ergonomic Hazard	Wrist injuries or musculoskeletal disorders (MSDs)

Table 2. Potential Dangers and Categories of Hazard Associate with Melting Work

Categories of Hazard	Potential Hazard
Physical Hazard	Falls from a height
	Stumbled on equipment that was in the foot area
	Hit the equipment in the head area
	Blisters or burns due to exposure to hot litter
	Blisters or burns from touching the hot melter tank
Chemical Hazard	Eye irritation caused by turpentine liquid or turpentine vapor exposure
	Irritant effects, vertigo, headache, difficulty breathing, and pulmonary edema caused by turpentine vapor exposure
	Skin irritation and allergy caused by turpentine splash
Ergonomic Hazard	Wrist injuries or musculoskeletal disorders (MSDs)
	Upper arm pain or musculoskeletal disorders (MSDs)

Table 3. Potential Dangers and Categories of Hazard Associate with Scrubbing Work

Categories of Hazard	Potential Hazard
Physical Hazard	Hit the equipment in the head area
	Stumbled on equipment that was in the foot area
Ergonomic Hazard	Back pain or musculoskeletal disorders (MSDs)
	Wrist injuries or musculoskeletal disorders (MSDs)

Table 4. Potential Dangers and Categories of Hazard Associate with Cooking Work

Categories of Hazard	Potential Hazard
Physical Hazard	Falls from a height
	Hit the equipment in the head area
	Stumbled on equipment that was in the foot area
	Exposure to hot liquid gum rosin
	Cooking noise
Chemical Hazard	Irritating to the respiratory system, lung damage, vertigo, increased heart rate, dizziness, hallucinations, fire and burning sensation on the skin, conjunctivitis, and damage to the body's defense system due to inhaling cooking odors
Ergonomic Hazard	Wrist injuries or musculoskeletal disorders (MSDs)
	Upper arm pain or musculoskeletal disorders (MSDs)
	Leg injuries or musculoskeletal disorders
	Back pain or musculoskeletal disorders (MSDs)

Table 5. Potential Dangers and Categories of Hazard Associate with Canning Work

Categories of Hazard	Potential Hazard
Physical Hazard	Exposure to hot liquid gum rosin
	Canned lid hook
	Leg hit by can
Chemical Hazard	Respiratory tract infections from inhaling spray paint
	Irritation to skin and eyes due to spray paint exposure
Ergonomic Hazard	Leg injuries or musculoskeletal disorders
Mechanical Hazard	Get run over, hit and fall off a forklift

Table 6. Potential Dangers and Categories of Hazard Associate with PGT Waste Work

Categories of Hazard	Potential Hazard
Physical Hazard	Dropped into the tub Slip and fall
Chemical Hazard	Irritant effects, vertigo, headache, difficulty breathing, and pulmonary edema due to the smell of turpentine
Ergonomic Hazard	Upper arm pain or musculoskeletal disorders (MSDs)

3.4. Hazard Prevention Strategies

Hazard prevention strategies that can be done can be in the form of the use of PPE (personal protective equipment) and other things. Table 7 shows the potential hazards and hazard precautions associated with gutter work. Table 8 shows the potential hazards and hazard precautions associated with melting work. Table 9 shows the potential hazards and hazard precautions associated with scrubbing work. Table 10 shows the potential hazards and hazard precautions associated with cooking work. Table 11 shows the potential hazards and hazard precautions associated with canning work. Table 12 shows the potential hazards and hazard precautions associated with PGT waste work.

Table 7. Precautions to Minimize Possible Dangers Associate with Gutter Work

Potential Hazard	Precautions
Falls from a height	Ensure that the floor, stairs, and factory steps are clean and not slippery Use non-slip safety shoes Use a height protection device (body harness) Use head protection (safety helmet)
Eye irritation caused by steam vapor exposure	Use eye protection with side shields (safety glasses with side shields) Use face shields
Respiratory burn caused by steam vapor aspiration	Ensure there is adequate air circulation Use respiratory protective equipment (respirator)
Skin burn caused by steam vapor exposure	Use personal protective equipment (lab coat, protective clothing, or fire-resistant clothing) Use heat-resistant hand protective equipment (asbestos gloves) Use head protection (safety helmet)
Wrist injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly

Table 8. Precautions to Minimize Possible Dangers Associate with Melting Work

Potential Hazard	Precautions
Hit the equipment in the head area	Ensure that the floor, stairs, and factory steps are clean and not slippery Use non-slip safety shoes Use a height protection device (body harness) Use head protection (safety helmet)
Hit the equipment in the head area	Ensuring adequate lighting in the factory Check the condition of the eyes regularly to be aware of visual disturbances Use head protection (safety helmet)
Stumbled on equipment that was in the foot area	Ensure that the floor, stairs, and factory steps are clean and not slippery Ensuring adequate lighting in the factory Check the eyes condition regularly to be aware of visual disturbances Use non-slip safety shoes Use head protection

Table 8. (continued)

Potential Hazard	Precautions
Blisters or burns due to exposure to hot litter	Use heat-resistant hand protective equipment (asbestos gloves) Use head protection (safety helmet)
Blisters or burns from touching the hot melter tank	Use heat-resistant hand protective equipment (asbestos gloves) Use head protection (safety helmet)
Eye irritation caused by turpentine liquid or turpentine vapor exposure	Use eye protection with side shields (safety glasses with side shields)
Irritant effects, vertigo, headache, difficulty breathing, and pulmonary edema caused by turpentine vapor exposure	Ensure there is adequate air circulation Use respiratory protection (respirator)
Skin irritation and allergy caused by turpentine splash	Use chemically resistant hand protection equipment (0.3 mm nitrile rubber gloves) Using barrier creams/ointments
Wrist injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Upper arm pain or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly

Table 9. Precautions to Minimize Possible Dangers Associate with Scrubbing Work

Potential Hazard	Precautions
Hit the equipment in the head area	Ensuring adequate lighting in the factory Check the condition of the eyes regularly to be aware of visual disturbances Use head protection (safety helmet)
Stumbled on equipment that was in the foot area	Ensure that the floor, stairs, and factory steps are clean and not slippery Ensuring adequate lighting in the factory Check the condition of the eyes regularly to be aware of visual disturbances Use non-slip safety shoes Use head protection (safety helmet)
Wrist injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Back pain or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly

Table 10. Precautions to Minimize Possible Dangers Associate with Cooking Work

Potential Hazard	Precautions
Falls from a height	Ensure that the floor, stairs, and factory steps are clean and not slippery Use non-slip safety shoes Use a height protection device (body harness) Use head protection (safety helmet)

Table 10. (continued)

Potential Hazard	Precautions
Stumbled on equipment that was in the foot area	Ensure that the floor, stairs, and factory steps are clean and not slippery Ensuring adequate lighting in the factory Check the condition of the eyes regularly to be aware of visual disturbances Use non-slip safety shoes Use head protection (safety helmet)
Hit the equipment in the head area	Ensuring adequate lighting in the factory Check the condition of the eyes regularly to be aware of visual disturbances Use head protection (safety helmet)
Exposure to hot liquid gum rosin	Use of foot protective equipment (safety shoes) Use heat-resistant hand protective equipment (asbestos gloves) Use head protection (safety helmet) Installing a hot safety sign
Cooking noise	Use ear protection (ear plugs)
Irritating to the respiratory system, lung damage, vertigo, increased heart rate, dizziness, hallucinations, fire and burning sensation on the skin, conjunctivitis, and damage to the body's defense system due to inhaling cooking odors	Ensure there is adequate air circulation Minimizing contact time with cooking places Use respiratory protective equipment (respirator)
Wrist injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Upper arm pain or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Leg injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Back pain or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly

Table 11. Precautions to Minimize Possible Dangers Associate with Canning Work

Potential Hazard	Precautions
Exposure to hot liquid gum rosin	Use of foot protective equipment (safety shoes) Use heat-resistant hand protective equipment (asbestos gloves) Use head protection (safety helmet)
Canned lid hook	Use sharp-resistant hand protection (leather gloves) Pay close attention to the can lid when closing
Leg hit by can	Use of foot protective equipment (safety shoes)
Respiratory tract infections from inhaling spray paint	Use respiratory protective equipment (mask)
Irritation to skin and eyes due to exposure to spray paint	Use face shields Use eye protection (safety goggles) Use chemical resistant hand protection (rubber gloves)

Table 11. (continued)

Potential Hazard	Precautions
Leg injuries or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly
Get run over, hit and fall off a forklift	Don't cross the forklift path Give a sign when passing through the forklift lane Make sure there is no work in the forklift path Do not use HP when in the forklift area Disturbing the concentration of the forklift operator Ensure the footing is clean and dry Using a seat belt when in a forklift Rests on 3 points of contact when getting on and off the forklift Use protective footwear (safety shoes) and head protective equipment (safety helmet)

Table 12. Precautions to Minimize Possible Dangers Associate with PGT Waste Work

Potential Hazard	Precautions
Dropped into the tub	Installing the tub guardrail with worker steps Installing the tub depth safety sign Use of foot protective equipment (safety shoes) Use protective gloves (rubber gloves)
Slip and fall	Ensure that the floor and footing of PGT Waste are clean and not slippery Check the condition of the eyes regularly to be aware of visual disturbances Use non-slip safety shoes Use head protection (safety helmet)
Irritant effects, vertigo, headache, difficulty breathing, and pulmonary edema due to the smell of turpentine	Ensure there is adequate air circulation Use respiratory protective equipment (respirator)
Upper arm pain or musculoskeletal disorders (MSDs)	Stretching between work Warm up before doing work Do exercise regularly

3.4. Job Safety Analysis (JSA)

Job safety analysis consists of the work order, possible hazard and precautions, as well as the company name, date of manufacturing, and station site. This research resulted six Job Sheet Analysis (JSA) sheets. The JSA provided for each stations composed of work detailed activity, potential hazard and precautions.

4. Conclusion

Each of the six workstations at the Gum Rosin and Turpentine XYZ factory has a unique set of possible dangers and mitigation measures. There were four sorts of possible dangers discovered: physical hazards, ergonomic hazards, chemical hazards, and mechanical hazards. A total of six Job Safety Analysis (JSA) sheets were created for each station. This sheet includes the work order, possible dangers, and hazard precautions, as well as the company name, date of manufacturing, and station site.

The company's suggestions for improvement include giving strict sanctions to the workers who violate health and safety regulations and always advising workers related to health and safety, to construct a perimeter fence at the PGT waste station as several chemicals may cause harmful effects

if it splashed and to consider adding PPE such as safety glasses with side shields, respirators, 0.3 mm nitrile rubber gloves, body harness, and earplugs as an effort to protect workers.

Further research can do a risk assessment to classify the risk level of each hazard. Furthermore, it is necessary to validate the JSA by implementing the JSA within a certain time.

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