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Abstract: Ship demolition activities caused the soil at the location of the activity become contaminated with hydrocarbon due to spills or diesel, oil, and fat spills. The presence of hydrocarbon in the soil at high concentrations causes physical chemical damage to the soil. Monitoring of hydrocarbon pollution conditions on the soil can be conducted by detection of Total Petroleum Hydrocarbon (TPH) paramater. Hence, the aim of the research was to investigate the soil physical and chemical properties at two ships dismantling area. Samples were taken from two locations (soil 1 and soil 2) from ship demolition area in East Java. Some parameters such as TPH, cation exchange capacity (CEC), dust texture, clay texture, sand texture, P_2O_5 (bray), acidity, pH (KCl), total nitrogen, fatty oil, pH, K_2O, P_2O_5, C-organic, metals and heavy metals (i.e. lead (Pb), Cuprum (Cu) and Iron (Fe)) were determined based on the quality standard. The results showed that the concentration of TPH, Pb, Cu, Fe were upper than the quality standard at 2 locations. In conclusion, the area of ship dismantling have been contaminated by organic and inorganic pollutants.

1 INTRODUCTION

Ship-breaking or ship demolition is a type of ship disposal involving the breaking up of ships for either a source of parts, which can be sold for re-use, or for the extraction of raw materials, chiefly scrap. It may also be known as ship dismantling, ship cracking, or ship recycling. Modern ships have a lifespan of 25 to 30 years before corrosion, metal fatigue and a lack of parts render them uneconomical to operate. Ship-breaking allows the materials from the ship, especially steel, to be recycled and made into new products. This lowers the demand for mined iron ore and reduces energy use in the steelmaking process. Fixtures and other equipment on board the vessels can also be reused. While ship-breaking is sustainable, there are concerns about the use of poorer countries without stringent environmental legislation. It is also labour-intensive, and considered one of the world's most dangerous industries (Lord, 2013).

Ship-breaking has grown into a major occupational and environmental health problem in the world. It is amongst the most dangerous of occupations, with unacceptably high levels of fatalities, injuries and work-related diseases. Ship-breaking is a difficult process due to the structural complexity of the ships, and it generates many environmental and safety and health hazards. It is carried out mainly in the informal sector and is rarely subject to safety controls or inspection. Workers usually lack personal protective equipment and have little training, if at all. Inadequate safety controls, badly monitored work operations and high risk of explosions create very dangerous work situations. Workers have very limited access to health services and inadequate housing, welfare and sanitary facilities further exacerbate the plight of the workers (Makbul, 2010).

In addition to taking a huge toll on the health of workers, ship breaking is a highly polluting industry. Large amounts of carcinogens and toxic substances (PCBs, PVCs, PAHs, TBT, mercury, lead, isocyanates, sulfuric acid) not only intoxicate workers but are also dumped into the soil and coastal waters. An average size ship contains up to 7 tonnes of asbestos which is often sold in the local communities after scrapping. As the majority of yards have no waste management systems or facilities to prevent pollution, shipbreaking takes an enormous toll on the surrounding environment, the local communities, fishery, agriculture, flora and fauna. This naturally causes serious environmental damage with long-term effects for occupational, public and environmental health.

Ship demolition activities in Tanjung Jati, Bangkalan cause changes in environmental conditions due the influx of pollutants dominated by hydrocarbon compound spills. Spills or splashes of hydrocarbon compounds, such as diesel, bunkers, oil, and grease occur when ships are unloaded in the spare parts, ballast systems, as well as storage areas for fuel and lubricants. The presence of carbon compounds in the soil at high concentrations causes damage to the physical-chemical properties of the soil. Hydrocarbons, especially oil types, will increase the bulk density of the soil; decrease the capacity of the soil to bind water; increase the content of organic matter, carbon and nitrogen content; reduce the content of phosphorus, magnesium, calcium, sodium, and potassium; and reducing the penetration of plant roots into the soil (Kayode et al., 2009; Nwite and Alu, 2015).

Hydrocarbons are one of the most common contaminants that require remediation because they are closely related to human health and an indication of water pollution (Kirk et al., 2004). Hydrocarbon contaminants in soils that are difficult to decipher and are toxic will disrupt the growth of plants and other organisms that grow in them. Hydrocarbons have hydrocarbon components which are organic compounds (Handrianto et al., 2012). Hydrocarbon polluted soils are a big problem because they are difficult to degrade by microorganisms (Chijioke-Osuji et al., 2014).

Heavy metals are defined as metallic elements that have a relatively high density compared to water (Fergusson, 1990). With the assumption that heaviness and toxicity are interrelated, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure (Duffus, 2002). Although heavy metals are naturally occurring elements that are found throughout the earth’s crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds (He *et al.,* 2015; Herawati *et al.,* 2000). It has been reported that metals such as copper (Cu) and iron (Fe) are essential nutrients that are required for various biochemical and physiological functions whereas lead (Pb) are non-essential metals, as they are toxic, even in trace amounts (Fernandes *et al.*, 2013). The maximum limit under the standard is 0.50 mg/L for Pb, and 1.0 mg/L for Cu. Despite of their potential toxicity, many of these metals are still widely used.

The aim of this study was to determine the physical and chemical characteristics of soil at ship demolition area.

2 MATERIALS AND METHODS

2.1 Place of Research

This research was conducted at Environmental Remediation Laboratory, Department of Environmental Engineering, ITS and the Unilab Perdana Laboratory, Surabaya.

2.2 Material and Method

The steps in this research explain the stages of work that have been carried out in the research. The making of research steps aims to give the understanding and explanation in more detail through the description of each step. The steps in this research are explained as follows:

2.2.1 Sampling for Contaminated Soils

The contaminated soil that will be used in this study was obtained from the ship's demolition location in Tanjung Jati, Bangkalan, Madura. Retrieval of contaminated land was divided into two locations, Location 1 and Location 2. The difference between location 1 and location 2 was when the ship was unloaded. Location 2 had a longer operating time than Location 1. The distance between Location and Location 2 were 193.16 m. The location of ship dismantling can be seen in Figure 1.

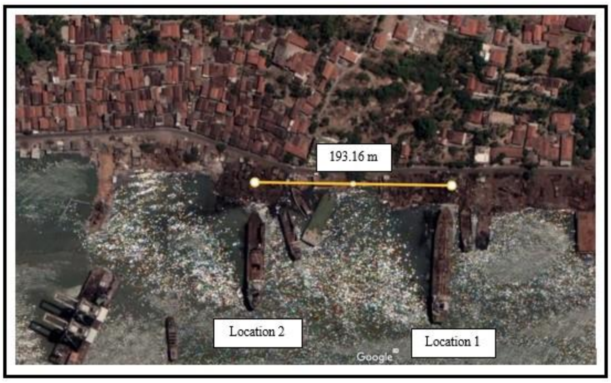

Fig 1. the location of ship dismantling

2.2.2 Soil Examination

The soil tests for two locations were carried out at Unilab Perdana Laboratory, Surabaya and used spectrophotometry, gravimetry, USEPA and APHA methods.

3 RESULTS AND DISCUSSION

Two locations of ship demolition activities that became the main material in this study, namely Location 1 and Location 2 were located in Tanjung Jati Village, Kamal District, Bangkalan District, Madura Island. Tanjung Jati village was one of the places famous for ship dismantling in Indonesia. Old and inoperable vessels were taken by shipbuilders to be processed into products that can be put back into the market chain. Ship construction consists mainly of steel, so the main target of the dismantling of these old vessels was to obtain steel which then became raw material for the manufacture of new ships or other products.

Hydrocarbon compounds can come from tanks, pipes, engines, ballast water, fuel waste, oil waste and grease obtained during the vessel cleaning stage (UNEP, 2003). In addition, ship disassembly activities are closely related to environmental pollution by metals and heavy metals, including iron (Fe), lead (Pb), mercury (Hg), cadmium (Cd), aluminum (Al), and zinc (Zn). Fe is a contaminant that is generally found in high concentrations at ship unloading locations (Rahman, 2017).

Ship demolition activities at Location 2 have been taking place for a longer time (operating since 2004) compared to Location 1 (operating since 2013). Laboratory tests on soil chemical parameters Location 1 and Location 2 were first performed. The results of laboratory tests on soil chemistry were presented in Table 1.

Table 1. Soil Physical and Chemical Characteristics at Research Sites

Parameter	Unit	Location 1	Location 2
Cation Exchange Capacity	me/100 g	4.02	4.27
Dust Texture	%	2.92	5.72
Clay Texture	%	0.15	0.14
Sand Texture	%	96.93	94.14
P_2O_5 (Bray)	mg/kg	76.8	85.90
Water Content	%	2.8	8.5
pH (KCl)	-	4.15	4.64
N-Total	%	0.12	0.16
Oils & Fats	%	8.08	12.40
pH	-	4.25	4.77
K_2O (HCl 25%)	mg/100 g	55.02	65.35
P_2O_5 (HCl 25%)	mg/100 g	117.73	120.00
C-Organic	%	8.04	9.23
Calcium (Ca)	mg/kg	348	417
Magnesium (Mg)	mg/kg	3,220	2,919
Potassium (K)	mg/kg	389	496
Natrium (Na)	mg/kg	1,494	2,499
Lead (Pb)	mg/kg	407	622
Iron (Fe)	mg/kg	589	816
Copper (Cu)	mg/kg	277	622
TPH	%	2.36	2.78

The value of the cation exchange capacity on the Location 1 was 4.02 me / 100 g and Location 2 soil was 4.27 me / 100 g so it can be said that both test sites have a low CEC. According to Utomo et al., (2016), the rougher the soil texture, the lower the CEC value of the soil. The pH value in the two test soils was around 4.25 (slightly alkaline) and this was consistent with the high dominance of the Na cation in the soil. Na saturation on Location 1 was 1,494 mg / kg and on Location 2 was 2,499 mg / kg. The higher the base cation in the sorption complex, the higher the base saturation of a soil. There is a positive relationship between base saturation and soil pH. The higher the base saturation, the higher the soil's pH.

The saturation of the cation was related to the release of the cation into the soil solution. The higher the saturation of a cation, the easier it was to be released into the soil solution, or in other words the cation is more easily available (Utomo et al., 2016). Base saturation was determined to estimate the level of base ion uptake in an exchange complex or easy base saturation can be used to determine the effectiveness of fertilization. The greater the percentage of soil base saturation, the more effective a fertilization on the soil (Subroto, 2003).

The critical limit of Cu and Pb concentrations in sandy soil containing 5% organic matter with a pH of 7 was 1 mg / kg and 0.5 mg / kg (Vries et al., 2007). According to Elgala et al., (1986), the critical limit for Fe in the sand soil is 3.4 mg / kg. The critical limit is the highest value of a contaminant that has a significant adverse effect on the receptor (which can be human health, ecosystem function and structure) on conditions not in a long-term perspective. The maximum allowable limit for the total petroleum hydrocarbon (TPH) parameter according to KepMenLH No. 128 of 2003 was 1% (10,000 mg / kg), while the TPH content in the test sites of Location 1 and Location 2 were 2.36% and 2.78. The presence of hydrocarbons decreases the ability of the soil to bind water (Nwite and Alu, 2015).

Based on the analysis of contaminant concentrations, both test soil samples have concentrations of Pb, Cu, Fe, and TPH far exceeding the critical limit. Therefore, the test soil from the demolition site Location 1 and Location 2 was said to be heavily polluted by hydrocarbons, Pb, Cu, and Fe.

Both the soil from Location 1 and Location 2, the results of laboratory tests conducted at the Unilab Perdana Laboratory, Surabaya showed a low total nitrogen content in the soil of 0.12% at Location 1 and 0.16% at Location 2 but both locations had organic C high at 8.04% at Location 1 and 9.23% at Location 2. In addition, the pH of the test soil from the ship unloading location in Tanjung Jati Village, both Location 1 and Location 2 were included in the low category so at this pH it could be difficult to degrade biologically because the ideal pH value for decomposition was pH 6-8 (Kostecki and Calabrese, 1992).

4 CONCLUSIONS

The results showed both the soil from Location 1 and Location 2 were heavily contaminated with organic and inorganic pollutants.

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