**SAFETY AND HEATH EVALUATION OF THE GAS EXPOSURE IN THE AREA OF EFFLUENT WATER TREATMENT PLANT**

**(ETWP) OF PT. X**

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**ABSTRAK**

Tujuan dari penelitian ini adalah untuk mengevaluasi keselamatan dan kesehatan paparan gas di area Effluent Water Treatment Plant (ETWP) PT. X. Metode yang digunakan untuk mengevaluasi keselamatan dan kesehatan paparan gas berdasarkan Permenaker No. 5/2018, yang menyatakan bahwa jika ada lebih dari satu zat kimia di udara di lingkungan kerja, Nilai Ambang Batas (TLV) dicampur , campuran bahan kimia tersebut dapat ditentukan dengan menghitung perbandingan antara kadar zat kimia dengan TLV, jika hasil perhitungan melebihi 1 (> 1) maka dianggap lulus TLV campuran (tidak aman). Hasil penelitian pada ketiga wilayah satuan menunjukkan bahwa TLV campuran sudah melebihi nilai 1 (>1) dan terdapat 2 dari 4 informan yang mengalami keluhan kesehatan akibat paparan gas yaitu sesak napas. Kesimpulan Paparan gas di 3 area Sludge Treatment Unit (DAF Scum Sump, Sludge Coagulator, Drying Box) pada pengukuran pertama, kedua dan ketiga tidak memenuhi persyaratan Nilai Ambang Batas Campuran (Mixed TLV) berdasarkan Peraturan Menteri Tenaga Kerja Peraturan Nomor 5 Tahun 2018 tentang Keselamatan dan Kesehatan Kerja di Lingkungan Kerja dan dapat diindikasikan bahwa daerah tersebut sangat berisiko. Metode pengendalian yang dilakukan adalah engineering control, administrasi dan Alat Pelindung Diri (APD).

**Kata kunci** : Effluent Water Treatment Plant (EWTP), Nilai Ambang Batas (TLV), Evaluasi Kesehatan dan Keselamatan Kerja, paparan gas, TLV campuran

***ABSTRACT***

*Objective of the research is to evaluate the safety and health of gas exposure in the area of Effluent Water Treatment Plant (ETWP) of PT. X. Methods used to evaluate the safety and health of gas exposure based on Permenaker No. 5/2018, which stated that if there is more than one chemical substance in the air in the work environment, the Treshold Limit Value (TLV) is mixed, the mixture of these chemicals can be determined by calculating the ratio between the levels of the chemical substance with the TLV, if the result of calculation exceeds 1 (> 1) then it is considered passed the TLV of the mixture (unsafe). The**Results of the research in the three areas of the unit showed that the mixed TLV has exceeded the value of 1 (>1) and there were 2 out of 4 informants who had health complaints due to the gas exposure namely shortness of breath.**Conclusions The gas exposure in 3 areas of the Sludge Treatment Unit (DAF Scum Sump, Sludge Coagulator, Drying Box) in the first, second and third measurements did not meet the Mixed Threshold limit Value (Mixed TLV) requirements based on the Minister of Manpower Regulation Number 5 Year 2018 concerning Occupational Safety and Health in the Work Environment and it can be indicated that the area is very risky. The control methods taken was engineering control, administration and Personal Protective equipment (PPE).*

***Keywords :*** *Effluent Water Treatment Plant (EWTP), Treshold Limit Value (TLV), Health and Safety Evaluation, gas exposure, mixed TLV*

**INTRODUCTION**

PT.X is an oil and gas company MIGAS) which is located in East Kalimantan Province. PT. X has a Liquid Waste Treatment Unit which is called the Effluent Water Treatment Plant (EWTP). The EWTP is a unit that processes residual / non-process liquid waste from oil and gas processing in all areas of the unit in the company. The EWTP processing unit has several processing units, such as a Filtering Unit, Equalization Unit, Chemical Precipitation Unit, PH Neutralization Unit, Flotation Unit, Activated Sludge Unit, Precipitation Unit, and Sludge Treatment Unit. (Alfarah,2017)

Domestic activities are a wastewater source that significantly pollutes river water in West Java (EPA, 2020), the province with the largest and most populous population in Indonesia (BPS, 2020). Domestic wastewater management in urban areas with high population density, such as in West Java, is carried out by improving and developing an area-scale centralized domestic wastewater management system (CDWMS). PAPs in the area-scale CDWMS generally apply anaerobic processing systems. This is due to the low costs for maintenance and operation because it does not require energy for the aeration process, can produce relatively small amounts of sludge, does not require a lot of nutrients, and the possibility of using the methane produced as an energy source (Aqaneghad & Moussavi, 2016). However, the area scale WWTP's performance is very dependent on the effectiveness and efficiency of the WWTP in removing contaminants or pollutants in the wastewater. Besides, the results of previous studies show that the communal wastewater distribution system does not fully function as a Plug Flow Reactor, so that the process of removing pollutant compounds in the pipes is minimal (Sururi et al., 2017), resulting  
in a considerable processing load on WWTP. Besides, most of the CDWMS areas in several cities in West Java were built in the 2013-2016 period, namely before the latest regulation on domestic wastewater management (Permen LHK No 68, 2016) was enacted.

On the other hand, currently, the Minister of Environment and Forestry Regulation No. 68/2016 applies which regulates the standard quality value of wastewater quality which is more  
stringent, so it is feared that the existing domestic PAPs work under design standards or criteria. Besides, daily fluctuations in the amount of treatment load and wastewater characteristics can affect the wastewater treatment process's success (Reynaud, 2016). Therefore it is essential to evaluate the performance of the WWTP in the CDWMS Kawasan by paying attention to daily fluctuations (at peak hours and not peak) and to determine the success rate of the WWTP in removing pollutant compounds and factors that affect the ability of WWTP removal, and ensuring the effluent of processing results is  
not. Harmful to the environment and society.

In managing industrial liquid waste, especially the liquid waste from oil and gas processing, it certainly has a byproduct in the form of sludge, the sludge is produced from the Chemical Precipitation Unit (formation of floc / fine solids) and then separated in the Flotation Unit between solids and water. For solid itself, it is flowed to the Sludge Storage Unit, while water that has been separated is flowed to the Activated Sludge Unit (Alfarah,2017).

It is confirmed that a hazardous and toxic gas is formed in the mud collection unit, because the sludge has biological activity (bacteria). The activity of these bacteria will decompose or react anaerobically (lack of oxygen), this happens because the sludge is deposited and there is sufficient free time for a putrefaction reaction from bacteria (biodegradation) to occur. It can also know that the results of anaerobic bacterial reactions (lack of oxygen) will certainly produce dangerous and toxic pollutants such as Methane (CH4), Ammonia (NH3), Hydrogen Sulfide (H2S) which makes water become septic with black color and odor (gas) that stung (Alfarah,2017).

The results of the data obtained by researchers from the local HSE show that in the area of the Mud Treatment Unit there is a gas content of Hydrogen Sulfide (H2S), Ammonia (NH3) and Benzene. (Permennaker, 2018)

According to the Minister of Manpower Regulation Number 5 of 2018, if there is more than one chemical substance in a work environment, the Threshold Value is Mixed TLV. In the sludge treatment process in the company there are also several workers, where they are tasked with carrying out manual handling during the sludge treatment process. (Permennaker, 2018)

**METHOD**

In this study, researchers used qualitative methods. This study used a qualitative approach because this study analyzed and described the calculation of the mixed gas as well as knowing workers' health complaints resulting from exposure to gases in the research location, namely the Effluent Water Treatment Plant (EWTP) in the Sludge Treatment Unit. The population in this study was the Sludge Treatment Unit at the Effluent Water Treatment Plant at PT. X. The samples in this study are Ammonia gas (NH3),Hidrogen Sulfide gas(H2S) and Benzene gas. Informans, In this study, there are 4 informants who worked in the Sludge Treatment Unit. Data collection tools, Gas Detector IBRID MX6; Multi Gas Detector IBRID MX6 which has been calibrated regularly according to the schedule determined by the calibration service company in collaboration with PT. X.

The following is the schedule for taking gas samples is in sludges treatment unit and the time of sampling techniques is Monday, Wednesday and Friday. The interview guide is used for in-depth interviews with contractor workers / partners as informants. The informants in this study were 4 Production Work Partners in the EWTP Area Mud Treatment Unit at PT. X.

Processing and Presentation of Data. The data obtained in the field is processed based on literature and combined with the results of interviews, as for the reference by researchers in this case is the Minister of Manpower regulation (Permenaker) No.5 of 2018 concerning the Work Environment. Data presentation in this research is narrative and tabulative.

**RESULT**

**Tabel 1. Result of Gas Unit Measurement and Mixed TLV Calculation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No** | **Location of measurement** | **Type of Gas** | **Result Of Measurement (Ppm Or Bds)** | | |
| **1** | **2** | **3** |
| 1 | DAF *Scum Sump* | NH3 | 5 | 3 | 3 |
| H2S | 5,4 | 4,4 | 4,9 |
| *Benzene* | 1,2 | 0,7 | 0,8 |
| 2 | *Sludge Coaguator* | NH3 | 7 | 24 | 3 |
| H2S | 5,0 | 16,7 | 5,5 |
| *Benzene* | 2,2 | 2,6 | 0,5 |
| 3 | *Drying Box* | NH3 | 6 | 9 | 5 |
| H2S | 11,1 | 7,8 | 6,2 |
| *Benzene* | 5,0 | 3,3 | 2,7 |

|  |  |  |  |
| --- | --- | --- | --- |
| No | Time Of Measurement | Location | Result of mixed TLV Calculation (ppm/bds) |
| 1 | First | *DAF Scum Sump* | 8 ppm |
| *Sludge Coag* | 9,68 pppm |
| *Drying Box* | 21,34 ppm |
| 2 | Second | *DAF Scum Sump* | 5,92 ppm |
| *Sludge Coag* | 22,86 ppm |
| *Drying Box* | 14,76 ppm |
| 3 | Third | *DAF Scum Sump* | 6,62 ppm |
| *Sludge Coag* | 6,62 ppm |
| *Drying Box* | 11,8 ppm |

**Analysis of Mixed TLV calculation**

The data from the measurement of gas exposure levels in 3 areas of the sludge treatment unit will be processed and calculated their Mixed TLV based on the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment, According to these regulations the Mixed TLV of these chemicals can be known by calculating the number of comparisons between the levels and the respective TLV, where if the calculation result exceeds the value of 1 then it is considered to have passed the Mixed TLV, the way to get the mixed TLV results can be described as follows:

Air contains 400 Bds of acetone (NAV 750 Bds), 150 Bds of secondary butyl acetate (TLV 200 Bds) and 100 Bds of methyl ethyl ketone (TLV 200 Bds).

Mixed grade = 400 Bds + 150 Bds + 100 Bds = 650 Bds.

To find out whether the mixed TLV is exceeded or not, these numbers are entered into the formula:

C1 + C2 + C3 = Cn =

TLV TLV TLV TLV

400 + 150 + 100 = 1.78

750 200 200

If the calculation result is more than 1 (one), then the mixed threshold value is exceeded, this calculation is in accordance with Permenaker Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment.

**Interview result**

The following are the results of the interview which have shown the number of questions asked during the data interview process, two (2) of 4 informants felt health complaints regarding exposure to gas, namely shortness of breath while working, while the other 2 informants did not have health complaints regarding exposure to gas, but there were health complaints in the form of work fatigue that occurred to the informants 3.

Whereas all informants receive complete Personal Protective Equipment facilities and state that all informants routinely use Personal Protective Equipment. Whereas all informants stated that they always use a cartridge mask when working.

Whereas 1 in 4 informants (informant 4) stated that they "do not really understand" how to use and care for cartridge masks. For the results of researchers' observations regarding control methods in the work area that there are controls in the form of,

**Observation Results of Control Methods in the Work Area**

In the Engineering Control the company provides a clothes washing machine that can be used by all workers, which functions to minimize the exposure to the gas that sticks to the workers' coveralls. In Administration Work procedures that take place according to the applicable SOP. The company provides nutritious drinks in the form of pure cow's milk to workers to maintain their health (neutralizes toxins in the body after work). In the Personnel Protective Equipment (PPE) The availability of standard PPE to special PPE that has been given to each worker who works in the waste treatment unit.

**DISCUSSION**

**Gas Measurement Results**

Measurement results 1, 2, 3 in the DAF Scum Sump, Sludge Coagulator and Drying Box areas, showed that the Ammonia gas (NH3) on the IBRID MX6 gas detector indicate that the number is still below the Ammonia Threshold Value (TLV), namely 25 bds or ppm based on the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment.

Measurement results 1, 2, 3 in the DAF Scum Sump, Sludge Coagulator and Drying Box area showed that the Hydrogen Sulfide (H2S) gas on the IBRID MX6 gas detector that indicate a number that exceeds the Threshold Value (TLV) of Hydrogen Sulfide ( H2S) which is 1 bds or ppm based on the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment.

Measurement results 1 and 2 in the DAF Scum Sump, Sludge Coagulator and Drying Box area showed that the Benzene gas on the IBRID MX6 gas detector that indicate a number that exceeds the Benzene Threshold Value (TLV), namely 0.5 bds or ppm while on measurement The three Bezena in the Sludge Coagulator area showed the same results according to the Threshold Value (NAV) which had been determined based on Permenaker No.5 of 2018 concerning Occupational Safety and Health in the Work Environment.

**Calculation of Mixed TLV**

Following the graph of the results from the sum of Mixed TLV on gas measurements that have been carried out in the DAF Scum Sump, Sludge Coagulator, Drying Box area.

From the results of the Mixed NAV calculation above, the DAF Scum Sump, Sludge Coagulator, Drying Box areas in the first, second and third measurements have exceeded Mixed NAV based on the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment.2

**Health Complaints against Gas Exposure**

That there are 2 out of 4 informants (informants 1 and 4) who have complaints about health due to exposure to gas, namely shortness of breath. Informants 1 and 4 complained about "shortness of breath" even when using Personal Protective Equipment (PPE), especially cartridge masks while working. For Informant 4 there were also interviews which stated that they "did not really understand" the use and care of cartridge masks.

Regarding Personal Protective Equipment, all informants are obedient to using Personal Protective Equipment, but informants 1 and 4 state that it is routine to use Personal Protective Equipment (PPE), especially on cartridge masks, but cartridge masks that are owned or used by informants 1 and 4 it turns out that its lifespan has ended (indicated by the smell of gas that has been smelled while still using the cartridge mask), so that informants 1 and 4 experienced "shortness of breath" even when using a cartridge mask.

All informants stated that they had carried out a Medical Check Up test and for the results of the MCU there was 1 informant (informant 1) who had “not good” MCU results, but the researchers had examined more deeply regarding the statement that the informant had sugar levels which is quite high.

**Control methods in the work area**

It can be seen that the Control Hierarchy consists of 5 points, namely: Elimination, Substitution, Engineering, Administration and Personal Protective Equipment.

The results of observations in the field are only controls in terms of Engineering, Administration and PPE. Any explanation are as follows , Elimination, for this first stage, that we cannot remove the gas content contained in the sludge which is the main feed/material of production in the sludge treatment unit, because the sludge has a time lag of days in the storage unit which can happen anaerobic bacteria (without oxygen) which produce a gas odor including Hydrogen Sulfide (H2S), Ammonia (NH3), Benzene.

Substitution, for this second stage the work process cannot be replaced or substituted in other ways to minimize potential hazards, unless a deeper engineering analysis and financial factors are carried out.

**CONCLUSION**

From the results of the Mixed TLV calculation, the exposure to gas in 3 areas of the Sludge Treatment Unit (DAF Scum Sump, Sludge Coagulator, Drying Box) in the first, second and third measurements does not meet the Mixed Threshold Value requirements based on the Minister of Manpower Regulation Number 5 Year 2018 concerning Occupational Safety and Health in the Work Environment and it can be indicated that the area is very risky.

Regarding the health complaints of workers in the sludge treatment unit area, it can be concluded that there are health complaints caused by exposure to gas, from 4 informants the results obtained were 2 informants did not experience complaints and 2 other informants experienced health complaints regarding exposure to gas, namely shortness of breath. Where this was caused by the two informants not being aware of the period of use of the cartridge (filter). Informant 4 also does not understand well how to use and care for cartridge masks, although informants 1 and 4 can be seen routinely using cartridge masks.

From the results of observations made by researchers in the area of the Sludge Treatment Unit, that the area has been controlled based on the control hierarchy, namely Engineering Control, Administration and Personal Protective Equipment (PPE)

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**REFERENCES**

Alfarah, Risya. (2017). *Analisis Kadar Gas Amonia (NH3) dan Hidrogen Sulfida (H2S) serta Keluhan Kesehatan pada Pekerja Pengelola Limbah di IPAL Departemen Utility PT.X Kota Batam Tahun 2017.* Medan: Universitas Sumatera Utara,2017

Artimani, Javad Salehi;., Arjman, Mehdi., Kalaei, Mohammad Reza.2015. *Modelling and Assesing Risk Analysis of Chlorine Gas in Water Treatment Plants.* European Journal of Environmental Biology.

Austigard, Ase Dalsets., Spendzen, Kristin., Heldal, Kari K.(2018). *Hydrogen Sulphide Exposure in Waste Water Treatment*. Journal of Occupational Medicine and Toxicology.

Falakh, Fajrul;., Setiani, Onny.(2018*). Hazard Identification and Risk Assesment in Water Treatment Plant Considering Environment Health and Safety Practice, E3S Web Conference*.

PERMENAKER Nomor 5 Tahun .(2018). *Tentang Kelamatan dan Kesehatan Kerja Lingkungan Kerja*.

SNI Nomor 19-023202005 *Tentang Nilai Ambang Batas Zat Kimia di Udara Tempat Kerja.*

Velasquez, Carlos Alberto Litardo., Perez, Grether Lucia Real at all.(2018). *Occupational Health and Safety Prevention Plant in Water Treatment Plants, International Journal of Life Sciences, Manabi.*

Vasovic, Dejan., Stancovc,Sandra M., Vranjanac, Zarco Goran (2018)*Working Condition At The Water Treatment Plants : Activities. Hazards, And Protective Measures, University Of Nis, Serbia*.

Malakahmad**,** Amirhossein and Done, Alan G**.**. (2012). *Application of Occupational Health and Safety Management System at Sewage Treatment Plants,IIEE Business,* Engineering and Industrial Application Collquium (BEIAC).

Peraturan Menteri Negara Lingkungan Hidup RI Nomor 19 Tahun 2010 *Tentang Baku Mutu Air Limbah Bagi Usaha dan/atau Kegiatan Minyak dan Gas Serta Panas Bumi.*