Poll Res. 38 (1) : 22-28 (2019)

ISSN 0257–8050

HIGH CHIMNEY WTE CALCULATIONS BY CONSIDERING PUBLIC HEALTH RISK BECAUSE OF FURAN / DIOXIN EMISSION

SAPTO PRAJOGO[1,2], ARI HANDONO RAMELAN[3], EVI GRAVITIANI[4] AND HARTONO[5]

[1]*Doctoral Program of Environmental Science, Sebelas Maret University, Surakarta Indonesia*
[2]*Energy Conversion Engineering Department,* Bandung *State* Polytechnic, *Bandung Indonesia*
[3]*Faculty of Mathematics and Natural Sciences, SebelasMaret University, Surakarta Indonesia*
[4]*Economics and Business Faculty, Sebelas Maret University, Surakarta Indonesia*
[5]*Medical Faculty, Sebelas Maret University, Surakarta Indonesia*

(Received 24 June, 2017; accepted 5 August, 2018)

ABSTRACT

Bandung City adopted a policy to build a waste incinerator technology (WTE) systems. The combustion capacity is 500 tons/day. WTE technologies will burn waste. WTE use energy generated to be converted to electrical energy. This technology has the potential to reduce the volume of waste more effectively. WTE also emits various harmful contaminants. Namely polychlorinated dibenzofurans (PCDF) and polychlorinated dibenzo-p-dioxins (PCDD). WTE equipped with chimney. So that the pollutants contained in the exhaust gas spread into the wider region. That intended to reduce the concentration of pollutants. This study intended to assess public health risks. That is, because due to PCDF / PCDD dispersion through this chimney. The calculations performed with the assumption of chimney height 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m. Public health risk assessment conducted for projections over the next 20 years. The causal relationship between the high of the chimney with the sick society obtained a linear regression equation. From the regression equation can do extrapolation chimney high is 277 m.

KEY WORDS : WTE, High chimney, Atmospheric Dispersion, Human health, Environmental toxins

INTRODUCTION

WTE is a waste incinerator technology, and utilizing energy generated to produce electricity. The technology has the potential to reduce the volume of waste more effectively. WTE has the potential to emit contaminants that have a negative impact on the environment, especially public health (ATSDR, 2005). The particulate contaminants such as dust, heavy metals, acid-forming gases chlorides, fluorides, and sulfur dioxide, volatile organic carbon also forming furans (polychlorinated dibenzofurans, PCDF) and dioxins (polychlorinated dibenzo-p-dioxins, PCDDs). All pollutants that easily spread in all directions through the air.

Contaminants generated have become a public concern is furan and dioxin. Furans and dioxin cause effects in an especially form of the disease area carcinogenic form of liver cancer. Waste to energy is equipped with a high chimney. The high build of the chimney is intended to attract high-existing air and subsequent pollutants contained in the exhaust gases to a wider area so as to reduce the concentration of pollutants.

In an effort to minimize public health risks as a result of PCDF/PCDD exposure, a study titled "High Chimney WTE Calculations by Considering Community Health Risk Because of Furan/Dioxin Emission" is necessary. This study will get high chimney that can provide minimal health impact.

METHOD

The release of contaminants into the environment causing the risk in its vast dimensions, one such risk is the human health effects. The purpose of the risk

***Corresponding author's email:** saptoprajogo@gmail.com

calculation process is to produce a quantitative estimate of the risk to human health posed by the release of contaminants into the environment (ATSDR, 2005, USEPA, 1989, EC & DGE, 2000 and Robert, 2007).

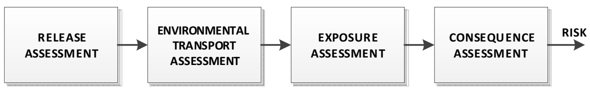

Fig. 1. Risk calculation component of the risk assessment process

In this study, presented as a four steps sequence shown in Fig. 1, which forecasts a removable, transport forecasts, forecasts of exposure, and forecasts consequences. Each of these steps will have a component of qualitative and quantitative components (Robert, 2007).

Efforts quantification of these externalities depends on the prediction rate of emission of contaminants. Referral popular is a document used emission factors are derived from the USEPA. The value of emission factors used as the basis for calculating the rate of emission by using the equation (ATSDR, 2005; USEPA, 2006; Robert, 2007 and Louvar & Louvar, 1998).

$$Q = EF \ x \ A \ x \ (1 - \frac{ER}{100}) \quad .. (1)$$

Where, Q (emission rate) is the amount pollutantsemitted per unit of time; EF (emission factor); A (rate of activity) is the intensity per unit time; and ER (emission reduction efficiency, in %).

Forecasts dispersion of emissions is determined at the beginning of this activity. The calculation results are used to create a model of contaminant dispersion pattern point source, and for it required a meteorological data. This meteorological data such as wind speed and atmospheric stability.

The following illustration shows the Gaussian Dispersion Formula. The resulting expression for the concentration at any point downwind of the release point (Robert, 2007 and Pasquill, 1983).

$$C(x,y,z) = \frac{S_0}{2\pi u \sigma_y \sigma_z} exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left\{exp\left[-\frac{(z-h)^2}{2\sigma_z^2}\right] + exp\left[-\frac{(z+h)^2}{2\sigma_z^2}\right]\right\} \quad .. (2)$$

Although the Gaussian dispersion formulas seem complicated, the manual calculation is still possible. Efforts to accelerate the process of calculation and reliability of calculation, so in this study will utilize the pollutant dispersion modeling program and a spreadsheet program, such as Microsoft Excel. In this study utilized disperse pollutants program SCREEN3. This pollutant disperse program requires technical specification data of the chimney (diameter, blast velocity, blast temperature, high), and additional data such as wind speed, atmospheric stability class, topographic condition information and point of view.

Output predicted impacts can be displayed as maps Isopleth dispersion region, this map was made to show an increase in the concentration of pollutants and an increase in the dispersion of pollutants in average conditions across the region dispersion. Gradation increase in average concentrations that may occur will be visualized on the map Isopleth (ATSDR, 2005; USEPA, 1992; Robert, 2007 and Pasquill, 1983).

Isopleth map is overlaid into thematic maps with demographic information. Results of these efforts are as basic data, which determine the health risk estimates on the distribution of impact across the region.

These are described as the way in which exposure to contaminants moves, ranging from environmental media into the body of a man who exposed. Exposure assessment in human populations exposed to be identified (receptors) as well as estimates of the rate at which humans exposed to contaminants. In this study, contaminants can enter the body and cause toxic effects simply through breathing. Intake levels of contaminants are mass or activity of contaminants entering the body per unit time (ATSDR, 2005 and Louvar & Louvar, 1998).

$$I = \frac{C \ x \ R \ x \ t_E \ x \ f_E \ x \ D_t}{W_b \ x \ t_{avg}} \quad .. (3)$$

Where, I is intake,mg/kg/day, C is risk agent concentration, mg/m^3, R is the rate of intake or consumption, m^3/hr for inhalation, t_E is Exposure Time, hours / day, $f_E$is frequency of exposure, day/year, $D_t$is the duration of exposure, years, $W_b$is weight, kg, $t_{avg}$is the average period of time. For carcinogens, D_t = 70 years (D_t × 365 days / year, 70 years x 365 days / year). Forecast incidence of cancer using a linear approach, non-threshold exposure to carcinogenic chemicals. The functional form of this relationship given in Equation (ATSDR, 2005 and Louvar and Louvar, 1998).

$$ECR = I_k\left(\frac{\frac{mg}{kg}}{day}\right) x \ CSF\left(\frac{\frac{mg}{kg}}{day}\right)^{-1} \quad .. (4)$$

Carcinogenic Risks expressed as ECR (Excess

Cancer Risk) and CSF (cancer slope factor). Slope factor is usually derived from experimental animal data. Slope factor published by the US EPA, based on a linear multistage (LMS). The results of ECR calculations and the number of exposed populations can be estimated by the number of sick people.

The calculations are repeated at high chimney conditions of 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m. Results of public health risk forecasts of high chimney change, followed by simple linear regression. This linear regression step by using SPSS software(Statistical Package for the Social Sciences). This activity will produce a curve and can be extrapolated to get the height of the safest chimney.

RESULTS AND DISCUSSION

In WTE, garbage is prepared to be burned in the furnace. The combustion heat energy is then converted to electrical energy. The combustion generates pollutants that are drained and discharged into the environment through the chimney.

Whatever the depth of the impact assessment is chosen, must begin by simulating disperse pollutants. WTE Gede Bage has a stationary source, controlled release with point source pattern of the stack. The technical specifications of the chimney are 1.5 m inner diameter, 20 m/s burst speed and 403oK burst temperatures. The height of the chimney is assumed to be 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m.

Burning capacity in WTE Gede Bage is 500 tons of waste per day, while EF (emission factor) PCDF / PCDD is 8.35E-07, and ER (emission reduction efficiency) is 90. Using equation 1, we can calculate the emission rate of 4.83E-07 gr/s.

This modeling effort, meteorological data used is data with an average time of 1 hour of recording time for 2 years and the data taken from the nearby station (BMKG: Geophysics Station Class I Bandung). The data is divided into two-time measurements, i.e. measurements of day and night measurements. Complete data on wind speed and direction needed to make Isopleth Map Regional Distribution. All wind direction must be taken into account in making the map, all data in each wind direction is summed and calculated average velocity. Table 1 shows the average velocity in each wind direction base on BMKG data.

Efforts to accelerate the process of calculation and reliability of calculation, so in this study will utilize the pollutant dispersion modeling program and a spreadsheet program, such as Microsoft Excel. In this study utilized disperse pollutants program, SCREEN3. This model does not require extensive meteorological data. Enough with just one set of data for each wind speed, atmospheric stability, and the ambient air temperature around the point of emission releases. This model will perform their own calculations by combining various wind speed and atmospheric stability classes that may occur. Results count SCREEN3 is a figure for the average time of 1 hour.

Table 1. Average speed and wind direction

Direction	Time Measurement (Average Speed) Night m/s	Day m/s
N	1.608009	1.884279
NNE	1.827736	2.065283
NE	1.735566	1.960605
ENE	1.748105	2.029694
E	1.675337	2.026544
ESE	1.684302	2.020109
SE	1.720983	1.932123
SSE	1.609503	1.927389
S	1.658464	1.869783
SSW	1.652034	1.750865
SW	1.632574	1.801452
WSW	1.673069	1.844106
W	1.806336	2.030414
WNW	1.831250	2.004615
NW	1.733099	1.949205
NNW	1.879268	1.981259

The first step to do is enter the data rate of emissions, for example for pollutants PCDF/PCDDs of 4.83E-6 g/s, 60 m high chimney, chimney inside diameter of 1.5 m, gas velocity out of the chimney 20 m/s, temperature gas from chimney 403°K, ambient air temperature of 293°K. Additional data such as wind speed, atmospheric stability class, topography and distance information review the points included. The calculation begins by choosing one of the wind directions, and the time is chosen, for example, the east wind blows at night. Table 2 shows that the average speed of the east wind that blows at night is 1.675337 m/s. In the same way in determining the speed of east wind for daytime. The calculation will result in the concentration of pollutant disperse in the east wind direction of the blow. Repeat the calculation steps for the other wind direction, and the concentration dispersion of PCDF / PCDD contaminants in 16 wind direction, and with 45 points of view (distance to the source of pollutant). Repeat all of these steps at high chimney conditions of 80 m, 100 m, 120 m, 140 m, 160 m, 180 m and 200 m.

In the case of the assessment of the influence of emission sources, not enough to just do an assessment of dispersed pollutants. This study also forecasts ambient air quality. Results of measurements of ambient air quality, indicating that the contaminant PCDF/PCDDs are undetected. In this study, ambient air quality is assumed to remain the same throughout the projection period of 20 years.

The results of these calculations will be made isopleth dispersion region map. This map was made to show the pattern of increase in the dispersion of pollutants in all regions of the dispersion. Gradation increase in average concentrations that may occur will be visualized on the map Isopleth this. Values increased concentration is calculated based on the average scene. Such information is needed to determine the impact of output forecasts. Isopleths dispersion region map that has been made can be seen in Fig. 2 (Prajogo, *et al.*, 2015).

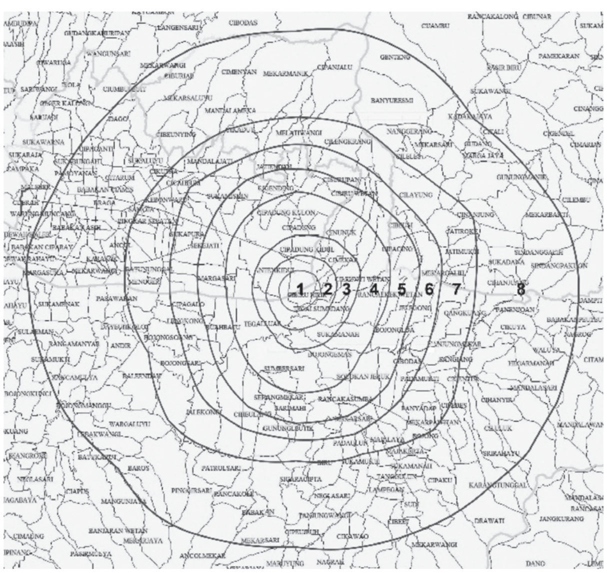

Fig. 2. Map isopleths dispersion region

Isopleth resulting map consists of 8 regions, and as a whole consists of 292 villages. Efforts forecast this externality associated with the effects of reduced public health. In this activity forecast the number of people affected, further data required a number of population in each area isopleths. It is known that the rate of population growth in West Java by 1.72%, then the sum of the number of people in the 8 regions isopleths and the estimated number of population projections for the period up to 20 years can be seen in Table 2.

Table 2. The estimated population in 8 regions isopleths during year 1 and year to 20

Region	Number of Population	
	the first year (people)	20^{th} year (people)
1	13,949	19, 287
2	35,380	48,919
3	53,469	73,930
4	241,817	334,355
5	355,318	491,290
6	464,860	642,751
7	515,119	712,243
8	2,085,035	2,882,930
Sum	3,314,731	4,677,720

Calculation by using SCREEN3 pollutant dispersion program will be obtained concentration dispersion PCDF/PCDD contaminant at 16 wind direction, and with 45 points of view (distance to the source of pollutant). Isopleths dispersion region map for pollutants PCDF/PCDDs will be known concentration of pollutant dispersion pattern of the increase in average conditions across the region dispersion effect. Isopleths map of the study area is divided into eight regions based on the level of similarity of dispersion of pollutants. Data on the concentration of the pollutant dispersion PCDF/PCDDs the dispersion region 8 and coupled with ambient air measurement data is shown in Table 3.

Regions obtained from the isopleths map as well as the assumption of anthropometric characteristics and patterns of activity can be calculated intake PCDF/PCDDs the exposure object. Anthropometric variables and patterns of activity consist of a weight, time of exposure, the frequency of exposure in one year and the duration of exposure. In this study in determining the anthropometric variables refer to the US EPA standards. Exposure object assumed to be static, and never considered anywhere. An understanding of these assumptions are considered the equal weight of 70 kg, the rate of inhalation (standard US EPA) are considered equal of 15.2 m^3/day, the daily exposure is 24 hours per day, the frequency of exposure is 365 days per year and the duration of exposure to 20 years. The result of calculation with equation 3) can be seenin Table 4. Changing the air quality for pollutants PCDF/PCDDs cause an impact on public health. Pollutants PCDF/PCDDs cause impacts that are a carcinogenic form of liver cancer. When intake of PCDF/PCDDs known the next is the calculation of the health risks. Carcinogenic Risks expressed as ECR (Excess Cancer Risk). Referring to the US-EPA, the value of CSF (cancer slope factor) PCDF/PCDDs at 1.5E+05 $(mg/kg/d)^{-1}$.

Using equation 4, it can be calculated as ECR. The results of ECR calculations due to PCDF/PCDD exposure in 8 isopleths regions and projected exposure time up to 20 years can be seen in Table 5.

ECR fore cast results will be determined by the number of cases of liver cancer patients in every region isopleths. For the example, the ECR at 2.02E-05 showed that out of a population of 100,000 people obtained forecasts the number of people potentially affected by liver cancer disease as much as 2 people. Furthermore, from the data in Table 2, which is about the estimated population in 8 isopleths areas at the time of year 20, the results of the public health risk assessment are shown in Table 6. That shows the largest number of liver cancer patients located in isopleths 8 area, it can be

Table 3. Concentration CDD in 8 regions

Region	Concentrations of CDD in high-chimney conditions							
	60m mg/m^3	80m mg/m^3	100m mg/m^3	120m mg/m^3	140m mg/m^3	160m mg/m^3	180m mg/m^3	200m mg/m^3
1	5.78E-10	4.07E-10	3.17E-10	2.59E-10	2.16E-10	1,82E-10	1.54E-10	1.17E-10
2	8.69E-10	5.49E-10	4.02E-10	2.86E-10	2.24E-10	1.72E-10	1.56E-10	1.47E-10
3	7.93E-10	5.81E-10	4.24E-10	3.10E-10	2.30E-10	1.76E-10	1.41E-10	1.19E-10
4	6.15E-10	4.90E-10	3.91E-10	3.11E-10	2.47E-10	1.97E-10	1.58E-10	1.30E-10
5	4.52E-10	3.80E-10	3.22E-10	2.72E-10	2.30E-10	1.93E-10	1.63E-10	1.37E-10
6	3.56E-10	3.08E-10	2.67E-10	2.33E-10	2.03E-10	1.77E-10	1.54E-10	1.33E-10
7	2.93E-10	2.57E-10	2.27E-10	2.02E-10	1.79E-10	1.59E-10	1.42E-10	1.26E-10
8	2.25E-10	2.00E-10	1.80E-10	1.63E-10	1.48E-10	1.34E-10	1.21E-10	1.10E-10

Table 4. Calculation intake.

Region	$I_{PCDF/PCDD}$in high-chimney conditions							
	60 m mg/kg/day	80 m mg/kg/day	100 m mg/kg/day	120 m mg/kg/day	140 m mg/kg/day	160 m mg/kg/day	180 m mg/kg/day	200 m mg/kg/day
1	3.47E-11	2.44E-11	1.90E-11	1.55E-11	1.30E-11	1.09E-11	9.24E-12	7.02E-12
2	5.21E-11	3.29E-11	2.41E-11	1.72E-11	1.34E-11	1.03E-11	9.36E-12	8.82E-12
3	4.76E-11	3.49E-11	2.54E-11	1.86E-11	1.38E-11	1.06E-11	8.46E-12	7.14E-12
4	3.69E-11	2.94E-11	2.35E-11	1.87E-11	1.48E-11	1.18E-11	9.48E-12	7.80E-12
5	2.71E-11	2.28E-11	1.93E-11	1.63E-11	1.38E-11	1.16E-11	9.78E-12	8.22E-12
6	2.14E-11	1.85E-11	1.60E-11	1.40E-11	1.22E-11	1.06E-11	9.24E-12	7.98E-12
7	1.76E-11	1.54E-11	1.36E-11	1.21E-11	1.07E-11	9.54E-12	8.52E-12	7.56E-12
8	1.35E-11	1.20E-11	1.08E-11	9.75E-12	8.85E-12	8.04E-12	7.26E-12	6.60E-12

Table 5. Calculation ECR

Region	ECR PCDF/PCDDin high-chimney conditions							
	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
1	5.21E-06	3.66E-06	2.85E-06	2.33E-06	1.94E-06	1.64E-06	1.39E-06	1.05E-06
2	7.82E-06	4.94E-06	3.62E-06	2.57E-06	2.02E-06	1.55E-06	1.40E-06	1.32E-06
3	7.14E-06	5.23E-06	3.82E-06	2.79E-06	2.07E-06	1.58E-06	1.27E-06	1.07E-06
4	5.54E-06	4.41E-06	3.52E-06	2.80E-06	2.22E-06	1.77E-06	1.42E-06	1.17E-06
5	4.07E-06	3.42E-06	2.90E-06	2.45E-06	2.07E-06	1.74E-06	1.47E-06	1.23E-06
6	3.20E-06	2.77E-06	2.40E-06	2.10E-06	1.83E-06	1,59E-06	1.39E-06	1.20E-06
7	2.64E-06	2.31E-06	2.04E-06	1.82E-06	1.61E-06	1.43E-06	1.28E-06	1.13E-06
8	2.03E-06	1.80E-06	1.62E-06	1.46E-06	1.33E-06	1.21E-06	1.09E-06	9.90E-07

described as the largest population in the region 8. In this study, the population with liver cancer due to exposure to dioxin/furan is determined by the height of the chimney, for which linear regression analysis is required, and the SPSS software is used. This simple linear regression analysis is used to measure the magnitude of the influence of a free variable or variable X to the dependent variable or variable Y. This independent variable is the height of the chimney, while the dependent variable is the community affected by liver cancer.

The result of simple linear regression analysis using SPSS software between the height of chimney with people affected by liver cancer, explaining the value of correlation (R) that is equal to 0.941, it can be interpreted that between the height of the chimney with the community affected by liver cancer has a very strong relationship. The analysis also yields the coefficient of determination (R square) of 0.885, which implies that the effect of the independent variable height of the chimney on the dependent variable of liver cancer patients is 88.5%

From the result of analysis got intercept an equal to 16,893 and regression coefficient b equal to -0,061, can be used to determine the regression equation. The functional or causal relationship between the high free variable of the smokestack with one dependent variable the number of liver cancer patients, obtained in the form of a simple linear regression equation as follows:

$$Y = a + bX$$

$$Y = 16.893 – 0.061X$$

The equation can be plotted in the linear form shown in Fig. 3. The curve shows that the higher the chimney will be the fewerpeople who suffer from

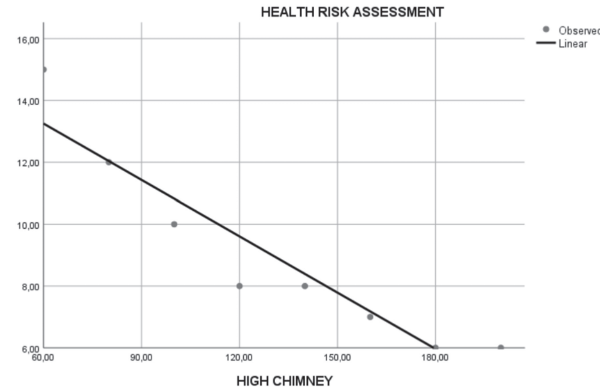

Fig. 3. High chimney relationship to the number of liver cancer patients

liver cancer. The safest condition, if there is no liver cancer. The next step will be to calculate the minimum height of the chimney that requires no people with liver cancer because of exposure to PCDD / PCDF. From the calculation obtained X = 277, or high chimney at least 277m.

$$16.893 - 0.061X = 0$$

$$0.061X = 16.893$$

$$X = \frac{16.893}{0.061}$$

$$X = 277$$

CONCLUSION

1. The causal relationship between the free variable height of the chimney with one dependent variable the number of liver cancer patients, obtained in the form of a simple linear regression equation Y = 16.893 - 0.061X.

Table 6. Results of the public health risk assessment

Region	Liver Cancer on the Condition of High Chimney							
	60 m people	80 m people	100 m people	120 m people	140 m people	160 m people	180 m people	200 m people
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0
4	2	1	1	1	1	1	0	0
5	2	2	1	1	1	1	1	1
6	2	2	2	1	1	1	1	1
7	2	2	1	1	1	1	1	1
8	6	5	5	4	4	3	3	3
Total	15	12	10	8	8	7	6	6

2. Chimney with 277 m height indicates the number of liver cancer patients equal to 0, so the height of the chimney should be at least 277 m.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 2005. *Public Health Assessment Guidance Manual*. Atlanta: U.S. Department of Health and Human Services, Public Health Service

Environmental Protection Agency, 1989. *Toxic Chemical Release Inventory Risk Screening Guide (Version 1).* Washington, DC: US EPA; EPA 560-2-89-002.

European Commission, DG Environment, 2000. A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste.

Fjeld, Robert A. 2007. *Quantitative Environmental Risk Analysis for Human Health*. A John Wiley & Sons, Inc., Publication, Hoboken, New Jersey.

Louvar, J. F. and Louvar, B.D. 1998. *Health and Environmental Risk Analysis: Fundamentals with Applications*. Upper Saddle River, N.J., Prentice Hall.

Pasquill, F. 1983. *Atmospheric Diffusion*. Ellis Horwood Limited, West Sussex, England.

Prajogo, S. 2015. Effect of Change in Rate of Emissions Furan/Dioxin of Public Health Risk on WTE Gede Bage*. Journal of Environmental Science and Engineering* A, Libertyville, IL 60048, USA.

USEPA, 1992. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources*, rev. Research Triangle Park, NC: US EPA; EPA 454-R-92-019.

USEPA, 2006. *Combustion Emissions from Hazardous Waste Incinerators, Boilers and Industrial Furnaces, and Municipal Solid Waste Incinerators - Results from Five STAR Grants and Research Needs*. Washington, DC: US EPA.

.

HIGH CHIMNEY WTE CALCULATIONS BY CONSIDERING PUBLIC HEALTH RISK BECAUSE OF FURAN / DIOXIN EMISSION

by Evi Gravitiani

Poll Res. 38 (1) : 22-28 (2019)

ISSN 0257–8050

HIGH CHIMNEY WTE CALCULATIONS BY CONSIDERING PUBLIC HEALTH RISK BECAUSE OF FURAN / DIOXIN EMISSION

SAPTO PRAJOGO[1,2], ARI HANDONO RAMELAN[3], EVI GRAVITIANI[4] AND HARTONO[5]

[1]*Doctoral Program of Environmental Science, Sebelas Maret University, Surakarta Indonesia*
[2]*Energy Conversion Engineering Department,* Bandung *State* Polytechnic, *Bandung Indonesia*
[3]*Faculty of Mathematics and Natural Sciences, SebelasMaret University, Surakarta Indonesia*
[4]*Economics and Business Faculty, Sebelas Maret University, Surakarta Indonesia*
[5]*Medical Faculty, Sebelas Maret University, Surakarta Indonesia*

(Received 24 June, 2017; accepted 5 August, 2018)

ABSTRACT

Bandung City adopted a policy to build a waste incinerator technology (WTE) systems. The combustion capacity is 500 tons/day. WTE technologies will burn waste. WTE use energy generated to be converted to electrical energy. This technology has the potential to reduce the volume of waste more effectively. WTE also emits various harmful contaminants. Namely polychlorinated dibenzofurans (PCDF) and polychlorinated dibenzo-p-dioxins (PCDD). WTE equipped with chimney. So that the pollutants contained in the exhaust gas spread into the wider region. That intended to reduce the concentration of pollutants. This study intended to assess public health risks. That is, because due to PCDF / PCDD dispersion through this chimney. The calculations performed with the assumption of chimney height 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m. Public health risk assessment conducted for projections over the next 20 years. The causal relationship between the high of the chimney with the sick society obtained a linear regression equation. From the regression equation can do extrapolation chimney high is 277 m.

KEY WORDS : WTE, High chimney, Atmospheric Dispersion, Human health, Environmental toxins

INTRODUCTION

WTE is a waste incinerator technology, and utilizing energy generated to produce electricity. The technology has the potential to reduce the volume of waste more effectively. WTE has the potential to emit contaminants that have a negative impact on the environment, especially public health (ATSDR, 2005). The particulate contaminants such as dust, heavy metals, acid-forming gases chlorides, fluorides, and sulfur oxide, volatile organic carbon also forming furans (polychlorinated dibenzofurans, PCDF) and dioxins (polychlorinated dibenzo-p-dioxins, PCDDs). All pollutants that easily spread in all directions through the air.

Contaminants generated have become a public concern is furan and dioxin. Furans and dioxin cause effects in an especially form of the disease area carcinogenic form of liver cancer. Waste to energy is equipped with a high chimney. The high build of the chimney is intended to attract high-existing air and subsequent pollutants contained in the exhaust gases to a wider area so as to reduce the concentration of pollutants.

In an effort to minimize public health risks as a result of PCDF/PCDD exposure, a study titled "High Chimney WTE Calculations by Considering Community Health Risk Because of Furan/Dioxin Emission" is necessary. This study will get high chimney that can provide minimal health impact.

METHOD

The release of contaminants into the environment causing the risk in its vast dimensions, one such risk is the human health effects. The purpose of the risk

***Corresponding author's email:** saptoprajogo@gmail.com

calculation process is to produce a quantitative estimate of the risk to human health posed by the release of contaminants into the environment (ATSDR, 2005, USEPA, 1989, EC & DGE, 2000 and Robert, 2007).

Fig. 1. Risk calculation component of the risk assessment process

In this study, presented as a four steps sequence shown in Fig. 1, which forecasts a removable, transport forecasts, forecasts of exposure, and forecasts consequences. Each of these steps will have a component of qualitative and quantitative components (Robert, 2007).

Efforts quantification of these externalities depends on the prediction rate of emission of contaminants. Referral popular is a document used emission factors are derived from the USEPA. The value of emission factors used as the basis for calculating the rate of emission by using the equation (ATSDR, 2005; USEPA, 2006; Robert, 2007 and Louvar & Louvar, 1998).

$$Q = EF \; x \; A \; x \; (1 - \frac{ER}{100}) \qquad .. (1)$$

Where, Q (emission rate) is the amount pollutantsemitted per unit of time; EF (emission factor); A (rate of activity) is the intensity per unit time; and ER (emission reduction efficiency, in %).

Forecasts dispersion of emissions is determined at the beginning of this activity. The calculation results are used to create a model of contaminant dispersion pattern point source, and for it required a meteorological data. This meteorological data such as wind speed and atmospheric stability.

The following illustration shows the Gaussian Dispersion Formula. The resulting expression for the concentration at any point downwind of the release point (Robert, 2007 and Pasquill, 1983).

$$C(x,y,z) = \frac{S_0}{2\pi u \sigma_y \sigma_z} exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left\{exp\left[-\frac{(z-h)^2}{2\sigma_z^2}\right] + exp\left[-\frac{(z+h)^2}{2\sigma_z^2}\right]\right\} \qquad .. (2)$$

Although the Gaussian dispersion formulas seem complicated, the manual calculation is still possible. Efforts to accelerate the process of calculation and reliability of calculation, so in this study will utilize the pollutant dispersion modeling program and a spreadsheet program, such as Microsoft Excel. In this study utilized disperse pollutants program SCREEN3. This pollutant disperse program requires technical specification data of the chimney (diameter, blast velocity, blast temperature, high), and additional data such as wind speed, atmospheric stability class, topographic condition information and point of view.

Output predicted impacts can be displayed as maps Isopleth dispersion region, this map was made to show an increase in the concentration of pollutants and an increase in the dispersion of pollutants in average conditions across the region dispersion. Gradation increase in average concentrations that may occur will be visualized on the map Isopleth (ATSDR, 2005; USEPA, 1992; Robert, 2007 and Pasquill, 1983).

Isopleth map is overlaid into thematic maps with demographic information. Results of these efforts are as basic data, which determine the health risk estimates on the distribution of impact across the region.

These are described as the way in which exposure to contaminants moves, ranging from environmental media into the body of a man who exposed. Exposure assessment in human populations exposed to be identified (receptors) as well as estimates of the rate at which humans exposed to contaminants. In this study, contaminants can enter the body and cause toxic effects simply through breathing. Intake levels of contaminants are mass or activity of contaminants entering the body per unit time (ATSDR, 2005 and Louvar & Louvar, 1998).

$$I = \frac{C \; x \; R \; x \; t_E \; x \; f_E \; x \; D_t}{W_b \; x \; t_{avg}} \qquad .. (3)$$

Where, *I* is intake,mg/kg/day, C is risk agent concentration, mg/m³, *R* is the rate of intake or consumption, m³/hr for inhalation, t_E is Exposure Time, hours / day, f_E is frequency of exposure, day/year, D_t is the duration of exposure, years, W_b is weight, kg, t_{avg} is the average period of time. For carcinogens, D_t = 70 years (D_t × 365 days / year, 70 years x 365 days / year). Forecast incidence of cancer using a linear approach, non-threshold exposure to carcinogenic chemicals. The functional form of this relationship given in Equation (ATSDR, 2005 and Louvar and Louvar, 1998).

$$ECR = I_k \left(\frac{\frac{mg}{kg}}{day}\right) x \; CSF\left(\frac{\frac{mg}{kg}}{day}\right)^{-1} \qquad .. (4)$$

Carcinogenic Risks expressed as ECR (Excess

Cancer Risk) and CSF (cancer slope factor). Slope factor is usually derived from experimental animal data. Slope factor published by the US EPA, based on a linear multistage (LMS). The results of ECR calculations and the number of exposed populations can be estimated by the number of sick people.

The calculations are repeated at high chimney conditions of 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m. Results of public health risk forecasts of high chimney change, followed by simple linear regression. This linear regression step by using SPSS software(Statistical Package for the Social Sciences). This activity will produce a curve and can be extrapolated to get the height of the safest chimney.

RESULTS AND DISCUSSION

In WTE, garbage is prepared to be burned in the furnace. The combustion heat energy is then converted to electrical energy. The combustion generates pollutants that are drained and discharged into the environment through the chimney.

Whatever the depth of the impact assessment is chosen, must begin by simulating disperse pollutants. WTE Gede Bage has a stationary source, controlled release with point source pattern of the stack. The technical specifications of the chimney are 1.5 m inner diameter, 20 m/s burst speed and 403oK burst temperatures. The height of the chimney is assumed to be 60 m, 80 m, 100 m, 120 m, 140 m, 160 m and 200 m.

Burning capacity in WTE Gede Bage is 500 tons of waste per day, while EF (emission factor) PCDF / PCDD is 8.35E-07, and ER (emission reduction efficiency) is 90. Using equation 1, we can calculate the emission rate of 4.83E-07 gr/s.

This modeling effort, meteorological data used is data with an average time of 1 hour of recording time for 2 years and the data taken from the nearby station (BMKG: Geophysics Station Class I Bandung). The data is divided into two-time measurements, i.e. measurements of day and night measurements. Complete data on wind speed and direction needed to make Isopleth Map Regional Distribution. All wind direction must be taken into account in making the map, all data in each wind direction is summed and calculated average velocity. Table 1 shows the average velocity in each wind direction base on BMKG data.

Efforts to accelerate the process of calculation and reliability of calculation, so in this study will utilize

Table 1. Average speed and wind direction

Direction	Time Measurement (Average Speed) Night m/s	Day m/s
N	1.608009	1.884279
NNE	1.827736	2.065283
NE	1.735566	1.960605
ENE	1.748105	2.029694
E	1.675337	2.026544
ESE	1.684302	2.020109
SE	1.720983	1.932123
SSE	1.609503	1.927389
S	1.658464	1.869783
SSW	1.652034	1.750865
SW	1.632574	1.801452
WSW	1.673069	1.844106
W	1.806336	2.030414
WNW	1.831250	2.004615
NW	1.733099	1.949205
NNW	1.879268	1.981259

the pollutant dispersion modeling program and a spreadsheet program, such as Microsoft Excel. In this study utilized disperse pollutants program, SCREEN3. This model does not require extensive meteorological data. Enough with just one set of data for each wind speed, atmospheric stability, and the ambient air temperature around the point of emission releases. This model will perform their own calculations by combining various wind speed and atmospheric stability classes that may occur. Results count SCREEN3 is a figure for the average time of 1 hour.

The first step to do is enter the data rate of emissions, for example for pollutants PCDF/PCDDs of 4.83E-6 g/s, 60 m high chimney, chimney inside diameter of 1.5 m, gas velocity out of the chimney 20 m/s, temperature gas from chimney 403°K, ambient air temperature of 293°K. Additional data such as wind speed, atmospheric stability class, topography and distance information review the points included. The calculation begins by choosing one of the wind directions, and the time is chosen, for example, the east wind blows at night. Table 2 shows that the average speed of the east wind that blows at night is 1.675337 m/s. In the same way in determining the speed of east wind for daytime. The calculation will result in the concentration of pollutant disperse in the east wind direction of the blow. Repeat the calculation steps for the other wind direction, and the concentration dispersion of PCDF / PCDD contaminants in 16 wind direction, and with 45 points of view (distance to the source of pollutant). Repeat all of these steps at high chimney conditions of 80 m, 100 m, 120 m, 140 m, 160 m, 180 m and 200 m.

In the case of the assessment of the influence of emission sources, not enough to just do an assessment of dispersed pollutants. This study also forecasts ambient air quality. Results of measurements of ambient air quality, indicating that the contaminant PCDF/PCDDs are undetected. In this study, ambient air quality is assumed to remain the same throughout the projection period of 20 years.

The results of these calculations will be made isopleth dispersion region map. This map was made to show the pattern of increase in the dispersion of pollutants in all regions of the dispersion. Gradation increase in average concentrations that may occur will be visualized on the map Isopleth this. Values increased concentration is calculated based on the average scene. Such information is needed to determine the impact of output forecasts. Isopleths dispersion region map that has been made can be seen in Fig. 2 (Prajogo, *et al*., 2015).

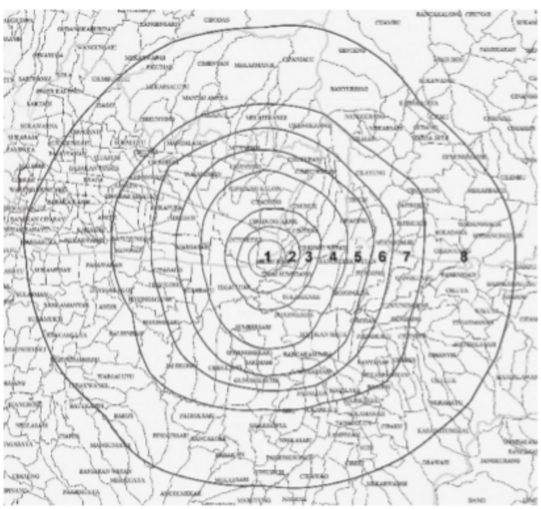

Fig. 2. Map isopleths dispersion region

Isopleth resulting map consists of 8 regions, and as a whole consists of 292 villages. Efforts forecast this externality associated with the effects of reduced public health. In this activity forecast the number of people affected, further data required a number of population in each area isopleths. It is known that the rate of population growth in West Java by 1.72%, then the sum of the number of people in the 8 regions isopleths and the estimated number of population projections for the period up to 20 years can be seen in Table 2.

Table 2. The estimated population in 8 regions isopleths during year 1 and year to 20

Region	Number of Population the first year (people)	Number of Population 20^{th} year (people)
1	13,949	19, 287
2	35,380	48,919
3	53,469	73,930
4	241,817	334,355
5	355,318	491,290
6	464,860	642,751
7	515,119	712,243
8	2,085,035	2,882,930
Sum	3,314,731	4,677,720

Calculation by using SCREEN3 pollutant dispersion program will be obtained concentration dispersion PCDF/PCDD contaminant at 16 wind direction, and with 45 points of view (distance to the source of pollutant). Isopleths dispersion region map for pollutants PCDF/PCDDs will be known concentration of pollutant dispersion pattern of the increase in average conditions across the region dispersion effect. Isopleths map of the study area is divided into eight regions based on the level of similarity of dispersion of pollutants. Data on the concentration of the pollutant dispersion PCDF/PCDDs the dispersion region 8 and coupled with ambient air measurement data is shown in Table 3.

Regions obtained from the isopleths map as well as the assumption of anthropometric characteristics and patterns of activity can be calculated intake PCDF/PCDDs the exposure object. Anthropometric variables and patterns of activity consist of a weight, time of exposure, the frequency of exposure in one year and the duration of exposure. In this study in determining the anthropometric variables refer to the US EPA standards. Exposure object assumed to be static, and never considered anywhere. An understanding of these assumptions are considered the equal weight of 70 kg, the rate of inhalation (standard US EPA) are considered equal of 15.2 m^3/day, the daily exposure is 24 hours per day, the frequency of exposure is 365 days per year and the duration of exposure to 20 years. The result of calculation with equation 3) can be seenin Table 4. Changing the air quality for pollutants PCDF/PCDDs cause an impact on public health. Pollutants PCDF/PCDDs cause impacts that are a carcinogenic form of liver cancer. When intake of PCDF/PCDDs known the next is the calculation of the health risks. Carcinogenic Risks expressed as ECR (Excess Cancer Risk). Referring to the US-EPA, the value of CSF (cancer slope factor) PCDF/PCDDs at 1.5E+05 $(mg/kg/d)^{-1}$.

Using equation 4, it can be calculated as ECR. The results of ECR calculations due to PCDF/PCDD exposure in 8 isopleths regions and projected exposure time up to 20 years can be seen in Table 5.

ECR fore cast results will be determined by the number of cases of liver cancer patients in every region isopleths. For the example, the ECR at 2.02E-05 showed that out of a population of 100,000 people obtained forecasts the number of people potentially affected by liver cancer disease as much as 2 people. Furthermore, from the data in Table 2, which is about the estimated population in 8 isopleths areas at the time of year 20, the results of the public health risk assessment are shown in Table 6. That shows the largest number of liver cancer patients located in isopleths 8 area, it can be

Table 3. Concentration CDD in 8 regions

Region	Concentrations of CDD in high-chimney conditions							
	60m mg/m³	80m mg/m³	100m mg/m³	120m mg/m³	140m mg/m³	160m mg/m³	180m mg/m³	200m mg/m³
1	5.78E-10	4.07E-10	3.17E-10	2.59E-10	2.16E-10	1,82E-10	1.54E-10	1.17E-10
2	8.69E-10	5.49E-10	4.02E-10	2.86E-10	2.24E-10	1.72E-10	1.56E-10	1.47E-10
3	7.93E-10	5.81E-10	4.24E-10	3.10E-10	2.30E-10	1.76E-10	1.41E-10	1.19E-10
4	6.15E-10	4.90E-10	3.91E-10	3.11E-10	2.47E-10	1.97E-10	1.58E-10	1.30E-10
5	4.52E-10	3.80E-10	3.22E-10	2.72E-10	2.30E-10	1.93E-10	1.63E-10	1.37E-10
6	3.56E-10	3.08E-10	2.67E-10	2.33E-10	2.03E-10	1.77E-10	1.54E-10	1.33E-10
7	2.93E-10	2.57E-10	2.27E-10	2.02E-10	1.79E-10	1.59E-10	1.42E-10	1.26E-10
8	2.25E-10	2.00E-10	1.80E-10	1.63E-10	1.48E-10	1.34E-10	1.21E-10	1.10E-10

Table 4. Calculation intake.

Region	$I_{PCDF/PCDD}$ in high-chimney conditions							
	60 m mg/kg/day	80 m mg/kg/day	100 m mg/kg/day	120 m mg/kg/day	140 m mg/kg/day	160 m mg/kg/day	180 m mg/kg/day	200 m mg/kg/day
1	3.47E-11	2.44E-11	1.90E-11	1.55E-11	1.30E-11	1.09E-11	9.24E-12	7.02E-12
2	5.21E-11	3.29E-11	2.41E-11	1.72E-11	1.34E-11	1.03E-11	9.36E-12	8.82E-12
3	4.76E-11	3.49E-11	2.54E-11	1.86E-11	1.38E-11	1.06E-11	8.46E-12	7.14E-12
4	3.69E-11	2.94E-11	2.35E-11	1.87E-11	1.48E-11	1.18E-11	9.48E-12	7.80E-12
5	2.71E-11	2.28E-11	1.93E-11	1.63E-11	1.38E-11	1.16E-11	9.78E-12	8.22E-12
6	2.14E-11	1.85E-11	1.60E-11	1.40E-11	1.22E-11	1.06E-11	9.24E-12	7.98E-12
7	1.76E-11	1.54E-11	1.36E-11	1.21E-11	1.07E-11	9.54E-12	8.52E-12	7.56E-12
8	1.35E-11	1.20E-11	1.08E-11	9.75E-12	8.85E-12	8.04E-12	7.26E-12	6.60E-12

Table 5. Calculation ECR

Region	ECR PCDF/PCDDin high-chimney conditions							
	60 m	80 m	100 m	120 m	140 m	160 m	180 m	200 m
1	5.21E-06	3.66E-06	2.85E-06	2.33E-06	1.94E-06	1.64E-06	1.39E-06	1.05E-06
2	7.82E-06	4.94E-06	3.62E-06	2.57E-06	2.02E-06	1.55E-06	1.40E-06	1.32E-06
3	7.14E-06	5.23E-06	3.82E-06	2.79E-06	2.07E-06	1.58E-06	1.27E-06	1.07E-06
4	5.54E-06	4.41E-06	3.52E-06	2.80E-06	2.22E-06	1.77E-06	1.42E-06	1.17E-06
5	4.07E-06	3.42E-06	2.90E-06	2.45E-06	2.07E-06	1.74E-06	1.47E-06	1.23E-06
6	3.20E-06	2.77E-06	2.40E-06	2.10E-06	1.83E-06	1,59E-06	1.39E-06	1.20E-06
7	2.64E-06	2.31E-06	2.04E-06	1.82E-06	1.61E-06	1,43E-06	1.28E-06	1.13E-06
8	2.03E-06	1.80E-06	1.62E-06	1.46E-06	1.33E-06	1.21E-06	1.09E-06	9.90E-07

described as the largest population in the region 8. In this study, the population with liver cancer due to exposure to dioxin/furan is determined by the height of the chimney, for which linear regression analysis is required, and the SPSS software is used. This simple linear regression analysis is used to measure the magnitude of the influence of a free variable or variable X to the dependent variable or variable Y. This independent variable is the height of the chimney, while the dependent variable is the community affected by liver cancer.

The result of simple linear regression analysis using SPSS software between the height of chimney with people affected by liver cancer, explaining the value of correlation (R) that is equal to 0.941, it can be interpreted that between the height of the chimney with the community affected by liver cancer has a very strong relationship. The analysis also yields the coefficient of determination (R square) of 0.885, which implies that the effect of the independent variable height of the chimney on the dependent variable of liver cancer patients is 88.5%

From the result of analysis got intercept an equal to 16,893 and regression coefficient b equal to -0,061, can be used to determine the regression equation. The functional or causal relationship between the high free variable of the smokestack with one dependent variable the number of liver cancer patients, obtained in the form of a simple linear regression equation as follows:

$$Y = a + bX$$

$$Y = 16.893 - 0.061X$$

The equation can be plotted in the linear form shown in Fig. 3. The curve shows that the higher the chimney will be the fewerpeople who suffer from

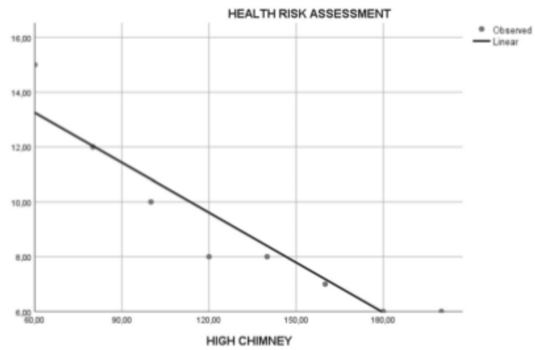

Fig. 3. High chimney relationship to the number of liver cancer patients

liver cancer. The safest condition, if there is no liver cancer. The next step will be to calculate the minimum height of the chimney that requires no people with liver cancer because of exposure to PCDD / PCDF. From the calculation obtained X = 277, or high chimney at least 277m.

$$16.893 - 0.061X = 0$$

$$0.061X = 16.893$$

$$X = \frac{16.893}{0.061}$$

$$X = 277$$

CONCLUSION

1. The causal relationship between the free variable height of the chimney with one dependent variable the number of liver cancer patients, obtained in the form of a simple linear regression equation Y = 16.893 - 0.061X.

Table 6. Results of the public health risk assessment

Region	Liver Cancer on the Condition of High Chimney							
	60 m people	80 m people	100 m people	120 m people	140 m people	160 m people	180 m people	200 m people
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0
4	2	1	1	1	1	1	0	0
5	2	2	1	1	1	1	1	1
6	2	2	2	1	1	1	1	1
7	2	2	1	1	1	1	1	1
8	6	5	5	4	4	3	3	3
Total	15	12	10	8	8	7	6	6

2. Chimney with 277 m height indicates the number of liver cancer patients equal to 0, so the height of the chimney should be at least 277 m.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 2005. *Public Health Assessment Guidance Manual*. Atlanta: U.S. Department of Health and Human Services, Public Health Service

Environmental Protection Agency, 1989. *Toxic Chemical Release Inventory Risk Screening Guide (Version 1).* Washington, DC: US EPA; EPA 560-2-89-002.

European Commission, DG Environment, 2000. A Study on the Economic Valuation of Environmental Externalities from Landfill Disposal and Incineration of Waste.

Fjeld, Robert A. 2007. *Quantitative Environmental Risk Analysis for Human Health*. A John Wiley & Sons, Inc., Publication, Hoboken, New Jersey.

Louvar, J. F. and Louvar, B.D. 1998. *Health and Environmental Risk Analysis: Fundamentals with Applications*. Upper Saddle River, N.J., Prentice Hall.

Pasquill, F. 1983. *Atmospheric Diffusion*. Ellis Horwood Limited, West Sussex, England.

Prajogo, S. 2015. Effect of Change in Rate of Emissions Furan/Dioxin of Public Health Risk on WTE Gede Bage. *Journal of Environmental Science and Engineering* A, Libertyville, IL 60048, USA.

USEPA, 1992. *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources*, rev. Research Triangle Park, NC: US EPA; EPA 454-R-92-019.

USEPA, 2006. *Combustion Emissions from Hazardous Waste Incinerators, Boilers and Industrial Furnaces, and Municipal Solid Waste Incinerators - Results from Five STAR Grants and Research Needs*. Washington, DC: US EPA.

HIGH CHIMNEY WTE CALCULATIONS BY CONSIDERING PUBLIC HEALTH RISK BECAUSE OF FURAN / DIOXIN EMISSION

ORIGINALITY REPORT

19%	18%	6%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.dartmouth.edu Internet Source	3%
2	is.muni.cz Internet Source	2%
3	www-nds.iaea.or.at Internet Source	2%
4	Submitted to University of New South Wales Student Paper	2%
5	www.envirobiotechjournals.com Internet Source	1%
6	semspub.epa.gov Internet Source	1%
7	www.epa.gov Internet Source	1%
8	randd.defra.gov.uk Internet Source	1%

9	Submitted to Middlesex University Student Paper	1%
10	Submitted to Griffth University Student Paper	1%
11	www.ijert.org Internet Source	1%
12	Submitted to Universitas Indonesia Student Paper	1%
13	www.semanticscholar.org Internet Source	<1%
14	www.candidagenome.org Internet Source	<1%
15	Submitted to University of Salford Student Paper	<1%
16	A F Faisya, Y Ardillah, D A Putri. "Hydrogen Sulfide Exsposure Coverage for Residents' Health Risk at Sukawinata Landfill", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<1%
17	mcf.gsfc.nasa.gov Internet Source	<1%
18	"The Analysis, Communication, and Perception of Risk", Springer Science and Business Media	<1%

LLC, 1991
Publication

19	regulations.vlex.com Internet Source	<1 %
20	rybn.org Internet Source	<1 %
21	repository.uinsu.ac.id Internet Source	<1 %
22	mafiadoc.com Internet Source	<1 %
23	repository.hkbu.edu.hk Internet Source	<1 %
24	worldwidescience.org Internet Source	<1 %
25	office-madoguchi.net Internet Source	<1 %
26	www.scribd.com Internet Source	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		

2.3

LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
KARYA ILMIAH : **JURNAL ILMIAH***

Judul Karya Ilmiah (artikel)	:	High Chimney WTE Calculations By Considering Public Health Risk Because Of Furan/ Dioxin Emission
Jumlah Penulis	:	4 Orang (Sapto Prajogo, Ari Handono R, **Evi Gravitiani**, Hartono)
Status Pengusul	:	~~Penulis pertama~~ / penulis ke 3 / ~~penulis korespondasi**~~
Identitas Jurnal Ilmiah	:	a. Nama Jurnal : **Pollution Research**
		b. Nomor ISSN : **0257-8050**
		c. Volume,nomor,bulan,tahun : **Vol. 38, No. 1, 2019**
		d. Penerbit : **EM International**
		e. DOL artikel (jika ada) :
		f. Alamat web Jurnal : http://www.envirobiotechjournals.com/article_abstract.php?aid=9293&iid=267&jid=4
		g. Terikdeks di Scimagojr/Thomson Reuter ISI knowledge atau di............**

Kategori Publikasi Jurnal Ilmiah (beri ˇ pada kategori yang tepat) :
- ☐ Jurnal Ilmiah Internasional / Internasional bereputasi.**
- ☐ Jurnal Ilmiah Nasional Terakreditasi
- ☐ Jurnal Ilmiah Nasional/Nasional terindeks di DOAJ, CABI, COPERNICUS**

Hasil Penilaian *Peer Review* :

Komponen Yang Dinilai		Nilai Maksimal Jurnal Ilmiah 40: Internasional/ Internasional bereputasi** ☐	Nasional Terakreditasi ☐	Nasional *** ☐	Nilai Akhir Yang Diperoleh
a.	Kelengkapan unsur isi artikel (10%)	4			3
b.	Ruang lingkup dan kedalaman pembahasan (30%)	12			11
c.	Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	12			11
d.	Kelengkapan unsur dan kualitas terbitan/jurnal (30%)	12			10
	Total = (100%)	**40**			**35**
	Nilai Pengusul = (40% x 35) /3 = 4.6 (Penulis Ketiga)				

Catatan Penilaian artikel oleh Reviewer :

a. Kelengkapan dan kesesuaian unsur isi artikel :
Artikel sesuai dengan gaya selingkung yang ditetapkan oleh jurnal dengan format abstract, method, result and discussion

b. Ruang lingkup dan kedalaman pembahasan :
Substansi artikel cukup bagus dan terkinikan, novelty yang dibentuk dalam artikel juga cukup bagus. Namun jumlah artikel yang dijadikan referensi hanya 8 dan tidak terbarukan

c. Kecukupan dan pemutakhiran data/informasi dan metodologi :
Data menggunakan data primer dan metodologi yang sesuai sehingga memberikan hasil yang bagus

d. Kelengkapan unsur dan kualitas terbitan :
Jurnal Pollution Research merupakan jurnal Scopus Q4 dengan H Indeks 22 dan SJR 0.13

e. Indikasi Plagiat :
Nilai turn it in sebesar 19% menunjukkan indikasi tidak adanya plagiarisme

f. Kesesuaian bidang ilmu :
Artikel ini merupakan bidang lingkungan yang sesuai dengan Ekonomi Pembangunan

Surakarta, 9 Desember 2020

Reviewer ½ **

Dr. Izza Mafruhah, SE, M.Si
NIP 197203232002122001
Jabatan : Lektor Kepala
Pangkat,Gol Ruang : IV/b
Unit Kerja : FEB
Bidang Ilmu : Ekonomi Pembangunan

*Dinilai oleh dua Reviewer secara terpisah
**Coret yang tidak perlu
***Nasional/terindeks di DOAJ,CABI,Copernicus

2.3

LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
KARYA ILMIAH : **JURNAL ILMIAH***

Judul Karya Ilmiah (artikel)	:	High Chimney WTE Calculations By Considering Public Health Risk Because Of Furan/ Dioxin Emission
Jumlah Penulis	:	4 Orang (Sapto Prajogo, Ari Handono R, **Evi Gravitiani**, Hartono)
Status Pengusul	:	~~Penulis pertama~~ / penulis ke 3 / ~~penulis korespondasi**~~
Identitas Jurnal Ilmiah	:	a. Nama Jurnal : **Pollution Research**
		b. Nomor ISSN : **0257-8050**
		c. Volume,nomor,bulan,tahun : **Vol. 38, No. 1, 2019**
		d. Penerbit : **EM International**
		e. DOL artikel (jika ada) :
		f. Alamat web Jurnal : http://www.envirobiotechjournals.com/article_abstract.php?aid=9293&iid=267&jid=4
		g. Terikdeks di Scimagojr/Thomson Reuter ISI knowledge atau di............**

Kategori Publikasi Jurnal Ilmiah (beri ˇ pada kategori yang tepat) :
- ☐ Jurnal Ilmiah Internasional / Internasional bereputasi.**
- ☐ Jurnal Ilmiah Nasional Terakreditasi
- ☐ Jurnal Ilmiah Nasional/Nasional terindeks di DOAJ, CABI, COPERNICUS**

Hasil Penilaian *Peer Review* :

	Komponen Yang Dinilai	Nilai Maksimal Jurnal Ilmiah 40: Internasional/ Internasional bereputasi** ☐	Nasional Terakreditasi ☐	Nasional *** ☐	Nilai Akhir Yang Diperoleh
a.	Kelengkapan unsur isi artikel (10%)	4			2
b.	Ruang lingkup dan kedalaman pembahasan (30%)	12			10
c.	Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	12			10
d.	Kelengkapan unsur dan kualitas terbitan/jurnal (30%)	12			10
	Total = (100%)	40			32
	Nilai Pengusul = (40% x 32) /3 = 4.3 (Penulis Ketiga)				

Catatan Penilaian artikel oleh Reviewer :

a. Kelengkapan dan kesesuaian unsur isi artikel: Artikel ini sudah sesuai dengan aturan standar penulisan ilmiah dalam Pollution Research (abstract, introduction, material and method, result and discussion, conclusion) (skor=2)

b. Ruang lingkup dan kedalaman pembahasan: Studi ini bertujuan untuk mengetahui hubungan tinggi cerobong asap terahadap kesehatan masyarakat di Daerah Bandung. Hasil penelitian menunjukkan tinggi cerobong asap yang optimum untuk kesehatan adalah setinggi 277 m (skor=10)

c. Kecukupan dan pemutakhiran data/informasi dan metodologi : Data yang dipergunakan dalam penelitian ini cukup mendalam dengan menggunakan data primer dan sekunder dengan menggunakan metode kuantitatif ekonometri model model regresi sederhana. (skor =10)

d. Kelengkapan unsur dan kualitas terbitan : Jurnal yang menerbitkan ini adalah jurnal internasional yang bereputasi dan terindeks scopus (skor=10)

e. Indikasi plagiat: Berdasarkan tes semiliritas hanya sebesar 19%, maka dapat diinyatakan tidak ada indikasi plagiat.

f. Kesesuaian bidang ilmu: Sangat sesuai bidang ekonomi terutama dalam bidang ekonomi pembangunan

Surakarta, ...04 DEC 2020.........

Reviewer 1/2 *

Lukman Hakim.,SE.,M.Si.,Ph.D
NIP. 196805182003121002

Jabatan	: Lektor Kepala
Pangkat,Gol Ruang	: Pembina / IV/a
Unit Kerja	: Fakultas Ekonomi dan Bisnis
Bidang Ilmu	: Ekonomi Pembangunan

*Dinilai oleh dua Reviewer secara terpisah
**Coret yang tidak perlu
***Nasional/terindeks di DOAJ,CABI,Copernicus